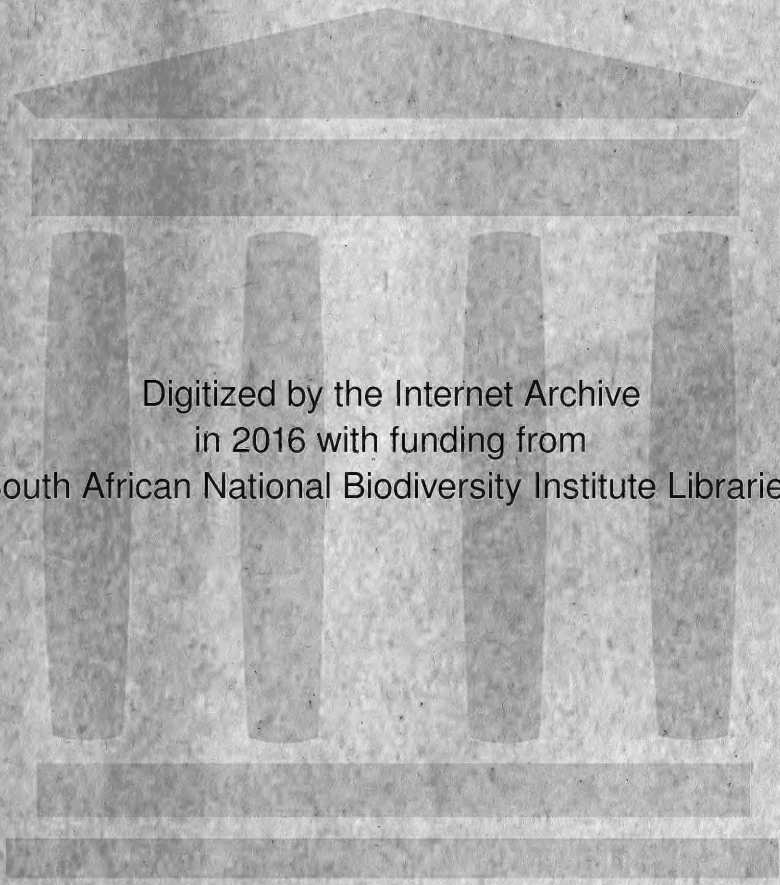

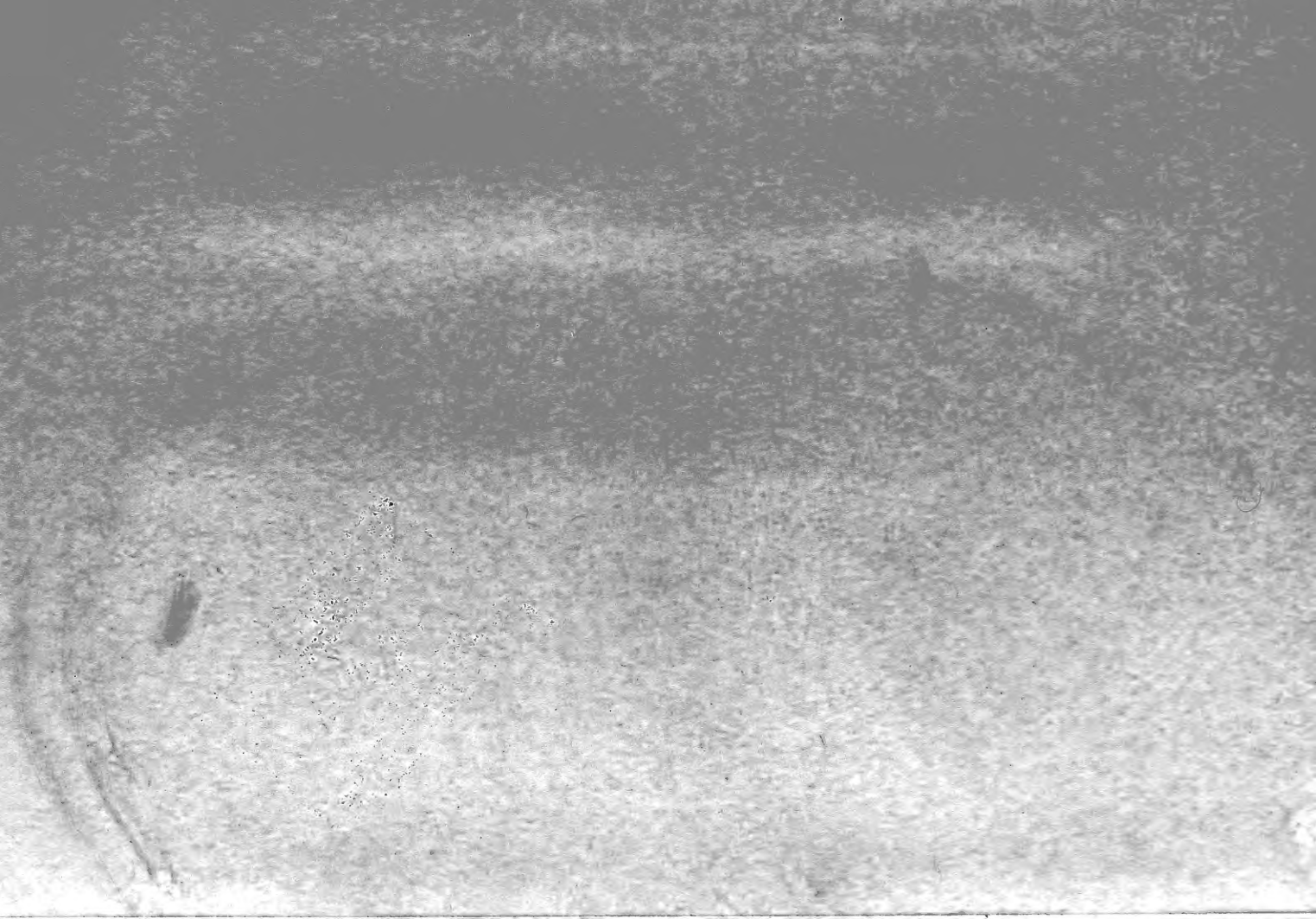

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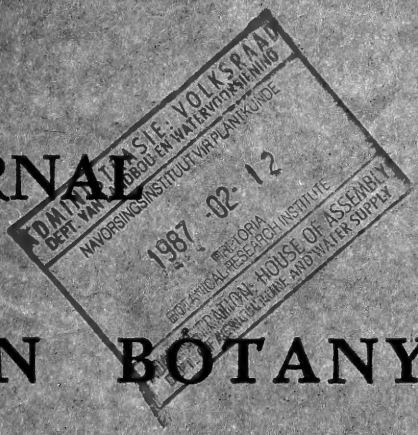

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THE JOURNAL OF SOUTH AFRICAN BOTANY.

The Trustees of the National Botanic Gardens of South Africa have undertaken responsibility for the publication of THE JOURNAL OF SOUTH AFRICAN BOTANY. This periodical publishes contributions embodying the results of botanical research in any of the various branches of the science. It provides a medium for the publication of work on the South African flora, whether systematic, ecological, morphological or otherwise, and whether carried out in South Africa or in other countries; and also on botanical subjects of special interest and application in South Africa.

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Vol. 3. 1937.

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Dark Green.

JOURNAL

OF

SOUTH AFRICAN BOTANY

VOL. III.

A REVISION OF *STOEBE* L.

By

MARGARET R. LEVYNS.

The genus Stoebe was founded by Linnaeus for certain members of Compositae in which the one-flowered capitula were massed in rounded heads. He established a separate genus Seriphium, for a number of allied plants in which the capitula were either spicately arranged or scattered on the branches. He included in these genera several plants now placed in Disparago and Elytropappus.

Lessing and De Candolle retained the names Stoebe and Seriphium, but finding that the inflorescence was somewhat variable proceeded to separate the two genera on characters of the achene. Stoebe, as defined by them, had a rim or annulus outside the pappus, while this feature was absent in Seriphium. Unfortunately this character, too, proved to be variable, and Harvey realising that it was impossible to uphold the two genera sank Seriphium in Stoebe when dealing with Compositae in the Flora Capensis. Bentham and Hooker and subsequent workers have followed him.

Up to the present time the pappus has been regarded as an essential feature of the genus, and those plants which lacked a pappus have been placed in the genus Perotriche. After a careful examination of all the species of both Stoebe and Perotriche the writer has come to the con-

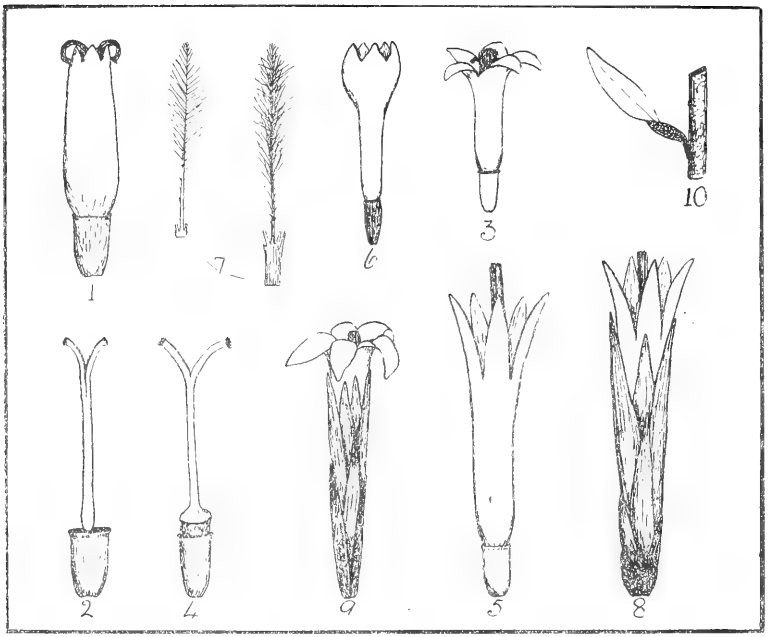

Fig. 1. *Stoebe incana.* Flower with pappus removed, ready for pollination × 12.

Fig. 2. *Stoebe incana.* Gynaeceum, the stage at which the style branches begin to emerge from the staminal tube × 12.

Fig. 3. *Stoebe prostrata.* Flower with the pappus removed, ready for pollination × 9.

Fig. 4. *Stoebe prostrata.* Gynaeceum, showing the swollen base of the style and disc × 12.

Fig. 5. *Stoebe nervigera.* Flower with pappus removed × 5.

Fig. 6. *Stoebe rosea.* Flower with pappus removed × 5.

Fig. 7. *Stoebe aethiopica* (left), *Stoebe rosea* (right). A single bristle of the pappus, showing the basal portions of adjoining bristles in each case × 10.

Fig. 8. *Stoebe nervigera.* Capitulum × 5.

Fig. 9. *Stoebe prostrata.* Capitulum × 10.

Fig. 10. *Stoebe prostrata.* Leaf × 2½.

clusion for reasons given below, that a more natural grouping of these plants is attained if the species of Perotriche be included in Stoebe. In an allied genus Disparago the pappus has been shown to be extremely variable (**5**), and species with and without a pappus have been accepted as belonging to this genus. According to Vavilov's law of homologous series in variation a specific difference occurring in one genus is likely to be repeated in a related one, and this appears to be the case here. Further support for the proposed transference of the species of Perotriche to Stoebe lies in the fact that three out of the four species have, in all respects but the pappus, their closest allies in species of Stoebe. For example, the plant at present known as *Perotriche tortilis* is so similar to *Stoebe capitata* that it is frequently assumed to be that plant until an examination has been made. The correspondence in nearly all details of structure between the two plants is so exact that it is impossible to place them far apart in any natural grouping of species. For these reasons Stoebe as defined in this paper includes forms with and without a pappus.

Basis of Classification.

The genus falls into two well-defined groups of species distinguished by the type of corolla and certain associated features. The importance of the shape of the corolla was clearly recognised by C. H. Schultz in 1861, but no previous writer had mentioned this feature. Figure 1 illustrates the first of these floral types. Here the corolla is tubular with small erect triangular lobes. The colour is usually a dull brown or purple, but may be yellow. When ready for pollination the style branches are considerably longer than the corolla and curl round outside it as shown in the figure. A further feature common to all members of this group is seen in the base of the style which may be slightly swollen but is never greatly enlarged and passes directly into the ovary (Fig. 2). This type of flower is characteristic of all the tropical species and several of the South African species. The second type of corolla is shown in Fig. 3. Here it will be noticed that the corolla lobes are relatively large and well developed, and in the open flower spread outwards The colour may be white or pink but is not purple, brown or yellow. A single exception to this rule may occasionally be found in *S. nervigera* where a purple colour has been recorded. The connectives of the anthers project from the throat of the corolla and in the majority of cases the style branches protrude from between the connectives but rarely extend outside the corolla. In most of the species of this group the style is greatly swollen at the base and in addition is seated on a waxy disc

which in fresh specimens is either yellow or orange in colour (Fig. 4.) Good examples of this type are *S. capitata*, *S. fusca* and *S. aethiopica*.

S. nervigera (Fig. 5) has rather narrower lobes than typical members of this second group, but when ready for pollination the corolla lobes show a strong tendency to spread. This species obviously belong to this group as all other features are normal. In *S. gomphrenoides*, *S. microphylla* and *S. leucocephala* the corolla lobes are long and narrow and more or less erect but in other respects these plants belong to this group though they form a distinct section within it. *S. alopecuroides* differs from other members of this section in lacking the swollen style base and disc. In certain vegetative features, notably the presence of short shoots, this plant approaches some widespread members of the first group, and if that group be regarded as primitive then *S. alopecuroides* retains some ancestral features which are lost in the more highly evolved members of the second group. *S. rosea* is an exceptional species in many respects though it has more in common with the second group than the first. Fig. 6 shows the form of the corolla. The upper part of the tube widens considerably but the small incurved lobes give it a globose appearance. The waxy disc at the base of the style is absent. Another feature in which this species is unique is the pappus. In all other species the pappus, when present, is feathered the lateral branches all lying in one plane (Fig. 7). In *S. rosea* the pappus bristles which are joined at their base for a greater distance than usual, have an untidy appearance due to the giving off of the lateral branches in all directions (Fig. 7), so that each bristle has a radial symmetry.

INVOLUCRE.

In plants belonging to the first group the involucral scales are arranged in several rows. The outermost are short and leaf-like and there is a gradual transition to the long, chaffy, innermost scales. In the species found in Madagascar and Reunion the capitula are borne singly at the ends of short leafy branches and it is impossible to define the limits of the purely vegetative part of the shoot and the capitulum which terminates it. In the African species the capitula are normally grouped in heads and the limits of the capitula are discernible.

Some members of the second group have an involucre of the same type as seen in the first group. This is seen in *S. fusca* and *S. nervigera* (Fig. 8). In others, however, there is a strong tendency to eliminate the leafy bracts at the base and for all the bracts to approach one another in size and texture. For instance, in *S. prostrata* (Fig. 9) it will be seen that there are no very short green bracts though the outermost bracts still have green tips. The highest expression of this tendency is seen in

S. capitata and S. bruniades where all the bracts approach one another in size and where all have a chaffy texture.

Vegetative Features.

Over half the African species of the first group (including the species that extend beyond the south-western coastal belt) have their vegetative axes differentiated into long and short shoots. This feature is not present in the second group with the single exception of *S. alopecuroides* where the short shoots are very noticeable.

The leaf shows certain constant features throughout the genus. The upper surface is invariably covered with a felt-like mat of hairs. The lower surface, on the other hand, may be glabrous or hairy. There is a strong involute tendency throughout the genus, leading in many cases to an ericoid type of leaf. A completely flat leaf is rare in this genus, and some degree of twisting is a common feature. In extreme cases a spiral form is assumed, but a more frequent type is that shown in Fig. 10 where, owing to torsion in the lower part of the leaf, the morphologically lower surface is placed uppermost. Throughout this paper the terms lower and upper surfaces are used in a morphological sense.

Hybridisation.

Hybridisation does not appear to occur frequently in the genus, and in this respect Stoebe presents a marked contrast to Elytropappus. However, on Table Mountain hybrids between *S. cinerea* and *S. incana* may be observed in many places. *S. cinerea* is a plant of low and moderate altitudes while *S. incana* ranges from about 1,800 feet to the summit. Their areas of distribution overlap and in this zone numerous hybrids occur. *S. cinerea* has an elongated inflorescence and short shoots are always present. *S. incana* has a rounded or oblong inflorescence and short shoots are not developed. Most of the hybrids are intermediate between the parents in both of these easily discernible features.

Variation.

As in most large genera certain species appear to be stable while others are so variable that they defy precise definition. It is a fact of interest that in Stoebe the variable species are those with a wide distribution, viz., *S. plumosa*, *S. vulgaris*, *S. capitata* and *S. aethiopica*. As the problems presented by these species are by no means uniform each species will be considered in turn.

S. plumosa is the most widespread of all the species ranging from

near Humpata in Portuguese West Africa, southwards to the Cape Peninsula and then eastwards to East London. Its altitudinal range is also considerable, extending from sea level to over 6,000 feet. At low altitudes it may be found growing in dry sand or in places that are water-logged during a considerable part of the year. The low altitude forms usually have an upright habit and grey plume-like branches, which character is suggested by the specific name *plumosa*. The lowland plants of dry habitats usually flower in the Autumn (the usual flowering period for the species of the genus as a whole) while those of moist places as far as observations go flower in the Spring. The flowering period of this species appears to be somewhat plastic as occasional plants have been found in flower at midwinter.

Forms characteristic of high altitudes are always stiffly and divaricately branched and at first sight appear very different from the soft plumose type mentioned above. However, the two types merge into one another and it is impossible to separate these forms. This species is normally somewhat woolly and the plants give a grey impression, but here and there in several localities (Malmesbury, Ceres, etc.) greenish plants with scanty wool are to be found growing with the type. These greenish plants often have a sharp mucro on the leaves of the main axis. Intermediate forms abound, however, and this type has obviously no claim to specific rank. At high altitudes a very woolly and rather coarse form has been recorded on several occasions. It is interesting to note that a related species, *S. incana*, is also prone to produce white, woolly forms at high altitudes, and the same phenomenon may be observed in Metalasia, another genus of the same alliance. The plants of this species occurring at high altitudes all appear to be Autumn flowering.

S. vulgaris, a species that is acquiring an unwelcome notoriety in the Transvaal owing to its aggressive habits in the grass-veld, appears to show a range of variation similar to that of *S. plumosa*. The stems and branches may be more or less erect or they may spread and the branching be of a divaricate type. In colour the plants range from grey to green according to the degree of woolliness, affording a close parallel with *S. plumosa* in the South. A considerable range in leaf size is encountered in this species, a form occurring on the border of Natal having leaves distinctly larger than that of the average Transvaal plant. However, even in one small area forms showing marked differences in leaf size will be encountered. The inflorescence may be freely branched or the glomerules may be much condensed, and borne close to the main axis giving a spike-like effect. In this latter type the vegetative parts show the same tendency to condensation, a phenomenon particularly common in Stoebe and allied genera.

In considering *S. vulgaris* it is impossible to resist drawing a comparison between this plant and *Elytropappus rhinocerotis* in the South. In both cases we are dealing with highly variable plants which under certain conditions have acquired aggressive features not usually encountered in plants growing in their native haunts. The case of *E. rhinocerotis* has been dealt with at length (**2**, **3**, **4**). Professor J. F. V. Phillips and Mr. C. Cohen are making an ecological study of *S. vulgaris* in the grassveld of the Transvaal where it is indisputably spreading at an alarming rate. The methods by which these two plants set about colonisation are entirely different, but the same vigour and adaptability are marked features of both.

S. capitata contains within the species two well-defined types which before a thorough investigation in the field had been made were assumed to be distinct. The first type which is the common one on the Cape Flats is a fairly stout plant with rounded or oblong heads and pink flowers. The innermost acuminate scales of the involucre slightly exceed the corolla tube in length, and the pappus is about as long as the tube. The corolla tube is approximately 3 mm. long. The second type which was given the name of *S. Mossii* by Spencer Moore, is abundantly represented in the neighbourhood of Sir Lowry's Pass. The plants are much more slender, the heads are smaller and rounded, and the flowers white or pale pink. The acute, innermost involucral scales are about the length of the corolla tube which is about 2 mm. long, while the pappus is delicate and distinctly shorter than the tube. These features suggested that these were two distinct but related species. However, the presence of occasional herbarium specimens which were intermediate in character made it desirable to visit a locality from which such intermediates had been obtained. Hermanus was such a place and consequently the area from Sir Lowry's Pass to Hermanus was made the object of special study. From Sir Lowry's Pass to Houw Hoek the plants were remarkably uniform, all of the slender type mentioned above. From Houw Hoek to Caledon owing to an unsuitable type of soil, this species was not seen, but between Caledon and Hermanus it was present in abundance on Shaw's Mountain. At the highest point on the road over the mountain all the plants were externally similar to the Cape Flats type while at the Hermanus end of the road the plants were intermediate in character. On dissection, however it was discovered that external form was no guide to details of flower structure. Twenty plants were collected at random over a fairly wide area at the highest point of the road. All these plants had the external features of the Cape Flats type, i.e. robust habit, round or oblong heads and deep pink flowers. The results of an examination of these plants is detailed below :—

		Involucral scales.	Pappus.	Length of corolla tube.
Cape Flats type		acuminate ..	As long as corolla tube ; bristles stiff.	3 mm.
Sir Lowry's Pass type ..		acute	Shorter than corolla tube ; bristles delicate.	2
Plants from Shaw's Mountain	10 plants	sub-acuminate ..	Shorter than corolla tube ; bristles intermediate.	3
	5 plants	sub-acuminate ..	Shorter than corolla tube ; bristles delicate.	2·5
	2 plants	sub-acuminate ..	Shorter than corolla tube ; bristles delicate.	2
	3 plants	acute	As long as corolla tube ; bristles intermediate.	2

The same phenomenon was observed in plants collected nearer Hermanus, though here the aspect of the plants was almost that of the Sir Lowry's Pass type. If the areas of distribution of the two types were partially dissimilar and the intermediate forms occurred where these areas overlapped, it would seem likely that the intermediate forms could best be explained as constituting a hybrid swarm. However, the areas of distribution are similar and both types frequently occur in the same locality. For the present it seems best to accept the species as a variable one and to regard these two forms as varieties which hybridise readily.

In places where the Cape Flats type grows plentifully it will be found on examining numerous individuals that the population is far from uniform. For instance, at Pollsmoor, near Tokai, in addition to the normal form which was the most abundant, some rather grey plants were observed, due to a greater development of hairs over the whole vegetative

surface. Other plants showed a general shortening of the internodes, resulting in a dwarf type.

An interesting mutation, very different in aspect from the type, which was also present, was observed in two instances among plants coming up after veld fires. These plants were obtained in two localities, one at Pollsmoor mentioned above (Levyns 5251) and the other in Klaver Valley, above Simonstown (Levyns 5523). This mutant is much stouter than the typical Cape Flats type with which it was growing in both cases. The leaves instead of being ericoid are almost flat. The general appearance is strongly suggestive of a tetraploid form but confirmation was not obtainable as in the first instance the inflorescence was too young and in the second the flowers were dead. No seed had been set in the second case, suggesting that sterility is a feature of this mutant as would probably be the case in an autotetraploid. A mutant of *Disparago lasiocarpa* (Levyns 5091), also collected on veld that had been burnt, is probably of the same nature.

In most previous accounts of this genus two related species, *S. aethiopica* L. and *S. phylicoides* Thunb. have been recognised. As far as their inflorescences and flowers are concerned no constant differences are to be observed. However, their vegetative features are very different. *S. aethiopica* is a low, much branched, densely leafy shrub. The leaves are markedly involute, almost ericoid, and have a definite twist. *S. phylicoides*, on the other hand, is a tall, straggling shrub with but occasional branches and the leaves are almost flat, straight and never crowded. Their areas of distribution are on the whole different, *S. aethiopica* being most abundant from the Cape Division to Uniondale, while *S. phylicoides* is centred in the Clanwilliam and Van Rhynsdorp Divisions. However in the southern part of the Clanwilliam Division, in the Ceres Division and on the mountain at Piquetberg forms occur which are intermediate in character between the two so-called species. A detailed study of these intermediates was made at Eland's Kloof in the North-West of the Ceres Division. These plants are a common constituent of the flora of the lower mountain slopes and are remarkably uniform in character. In all their vegetative features they lie half way between *S. aethiopica* and *S. phylicoides*. Their uniformity makes it difficult to regard these plants as a hybrid swarm, for in that case one would expect to find a degree of variability, some plants being like one parent and some like the other. This is one of these puzzling cases of a geographical series of forms where the extremes are very different but are connected by intergrades rendering separation impossible. In consequence all the forms have been merged in one species for which the older name, *S. aethiopica* L. is retained.

Under the heading of variation a phenomenon of rather a different type may be discussed. In certain species, notably *S. incana*, the ovaries show considerable variation in the same head. They may be glabrous, slightly hairy or very hairy, arranged in no particular sequence, all types being equally fertile. Numerous dissections were made of whole heads from plants, many of them collected in different places, in order to see if the predominating type of ovary bore any relation to either vegetative features or locality. No definite correlation could be made between hairiness of the vegetative parts and hairiness of the ovary. However, the plants collected on Table Mountain showed a higher proportion of hairy ovaries than those collected in other places.

Geographical Distribution.

So many facts of interest arise in connection with the geographical distribution of Stoebe that it is proposed to deal fully with the subject in a separate paper. A few outstanding facts, however, may be mentioned here.

The majority of the species are centred in the south-western corner of Africa, but the species are not confined to the coastal belt. In the West *Stoebe plumosa* has two outliers apart from its main area of distribution, one on the Auas Mountains near Windhoek and another in Portuguese West Africa near Humpata, at an altitude of about 6,000 feet. In the East *Stoebe vulgaris* is common in the Transvaal, and extends into Natal and Rhodesia. *Stoebe kilimandscharica* is a characteristic shrub of high altitudes in tropical Africa, reaching a little way North of the Equator. Two species are found in Madagascar and one in Reunion, all at high altitudes. It is a matter of considerable interest that all these species belong to the group with small, erect corolla lobes. The species with the spreading type of corolla are confined to the coastal belt and in general have rather restricted areas of distribution.

Seasonal Behaviour.

S. plumosa and *S. vulgaris* are closely related and have hitherto been regarded as the same species. It is therefore interesting to discover that in their seed germination and in the behaviour of the adult plant they show many similarities accompanied by some marked differences (1). *S. vulgaris* grows in regions with a summer rainfall, and it is therefore natural that its growing season should occur during the Summer months. Flowers are produced in the Autumn and the achenes are shed in the late Autumn or early Winter. During the cold dry winter the seeds remain dormant and germinate as soon as the summer rains occur. Tests made in Cape Town showed that the seed was capable of germina-

tion as early as August. *S. plumosa* occurs mainly in a region having a winter rainfall and a hot dry summer. It is therefore surprising to find that it exhibits the same seasonal habits at *S. vulgaris*. Active growth takes place in the driest months of summer, at a time when most other plants show little activity. The flowering season, with the few exceptions previously noted, is the same as that of the Transvaal plant. In this case, however, there is what would appear to be a decided advantage in the case of the Cape plant as when the achenes are shed conditions for germination are ideal. In spite of this they do not germinate. Attempts to germinate them in the laboratory have failed, whereas achenes of their Transvaal relative germinate readily under the same conditions. As far as can be judged from the evidence available at present, *S. plumosa* agrees with all the south-western species in that the seed does not germinate in its first year. Research on this aspect of the problem is still in progress, but it seems probable that the south-western Stoebes agree in this respect with *Elytropappus rhinocerotis* where a full year's rest is required before germination takes place (**4**).

In considering the facts stated above it is clear that the Transvaal plant is perfectly adjusted to the climatic conditions under which it grows. This, however, cannot be said of *S. plumosa*. Not only does it show vegetative activity when climatic conditions are most unfavourable but when perfect conditions for germination are present it appears to be unable to take advantage of them. The obvious deduction is that *S. plumosa* is derived from an ancestor which was adapted to conditions similar to those enjoyed by *S. vulgaris*, and that in spite of its apparently ingrained ancestral habits has been sufficiently plastic in other directions to adapt itself to the different climatic conditions of the South West Cape.

An interesting difference between the two species lies in the response to burning. After a fire *S. vulgaris* rejuvenates rapidly by means of buds which are present in large numbers at the base of the stems (**1**). *S. plumosa*, however, is killed by fire and is perpetuated by seedlings which come up vigorously after burning.

ACKNOWLEDGMENTS.

I wish to record my thanks for the generous assistance afforded by the Director of Kew, both as regards facilities for work at Kew and for help in dealing with problems which have arisen since my return to South Africa. Through the kindness of Professor Humbert to whom I tender my grateful thanks, the valuable Paris collection was sent to South Africa for examination. This collection is particularly rich in the species of Stoebe occurring outside the Union of South Africa and made a complete

study of the genus possible. I am indebted to Professor J. F. V. Phillips and Mr. C. Cohen for material and information with regard to the habits and behaviour of *Stoebe vulgaris*. Specimens housed in the Bolus Herbarium, the South African Museum, the National Herbarium at Pretoria and the British Museum have been examined and I wish to express appreciation of the courtesy of the directors of those institutions, My thanks are also due to the directors of the herbaria at Berlin, Geneva. Stockholm and Uppsala for the loan of type specimens. Finally I wish to acknowledge the assistance of the Botanical Survey in connection with expenses of transport during the latter part of this investigation.

STOEBE [Linn. Coroll. Gen. p. 14 (1737)]. Linn. Sp. Pl. ed. I, p. 831 (1753). *Seriphium* Linn. Sp. Pl. ed. I, p. 928 (1753).

Capitula 1-flowered, grouped in heads or solitary. *Involucral bracts* in few rows, the innermost dry and membranous, the outermost shorter, green and somewhat woolly or dry and membranous. *Receptacle* naked. *Floret* bisexual, tubular, regular, 5-lobed. *Style branches* truncate, pencilled at the summit. *Achenes* with or without a rim-like annulus. *Pappus* either of several plumose bristles, usually somewhat joined at the base, or none. Branched shrubs with small alternate leaves which are often ericoid and twisted.

Chiefly South African but with two species in Madagascar and one in Reunion. Species 34.

KEY TO THE SPECIES.

A. Corolla with small, erect lobes, purple brown or yellow ; style not or hardly swollen at the base, without a disc at its base.
  B^1 Vegetative parts differentiated into long and short shoots.
    C^1 A green shrub ; habit erect ; leaves obtuse, those on the short shoots granular .. .. 7. *Burchellii*
    C^1C^1 Colour usually grey-green, if green then plant is divaricately branched and the leaves not obtuse.
      D^1 Ovary with transverse lamellae on the upper part .. .. 8. *cinerea*
      D^1D^1 Ovary without transverse lamellae.
        E^1 Leaves of the short shoots minute, usually grain-like .. 6. *plumosa*
        E^1E^1 Leaves of the short shoots slender, not grain-like.
          F^1 Involucral bracts acuminate ; leaves usually less than 3 mm. ; pappus bristles about 12 .. .. 5. *vulgaris*
          F^1F^1 Involucral bracts obtuse or sub-acute ; leaves usually more than 3 mm. ; pappus bristles about 15 .. .. 4. *kilimandscharica*
  B^1B^1 Shoots of the vegetative parts all of one kind.
    C^2 Capitula borne singly at the ends of small shoots.
      D^2 Leaves completely obscuring the stem on young shoots .. .. 1. *cryptophylla*
      D^2D^2 Stem visible between the leaves on young shoots.
        E^2 Leaves with a sharp bend just above the point of insertion .. 2. *pachyclada*
        E^2E^2 Leaves erect, without a sharp bend above the point of insertion .. .. 3. *passerinoides*
    C^2C^2 Capitula borne several together in heads.
      D^3 Leaves spirally twisted.
        E^3 Involucral bracts brown .. .. 9. *incana*
        E^3E^3 Involucral bracts yellow .. .. 10. *spiralis*
      D^3D^3 Leaves not spirally twisted.
        E^4 Leaves glandular .. .. 11. *intricata*
        E^4E^4 Leaves eglandular .. .. 12. *saxatilis*

AA. Corolla lobes well developed and conspicuous (exc. *S. rosea*); pink or white (rarely purple in *S. nervigera*).
  B^2 Disc at the base of the style absent.
    C^3 Short shoots present; corolla white with spreading lobes .. .. 13. *alopecuroides*
    C^3C^3 Short shoots absent; corolla pink with small and somewhat incurved lobes .. .. 27. *rosea*
  B^2B^2 Swollen base of the style situated on a waxy disc.
    C^4 Inner involucral scales membranous, brown.
      D^4 Pappus present.
        E^5 Leaves pungent mucronate.
          F^2 Capitula massed in compact, rounded heads .. .. 26. *aethiopica*
          F^2F^2 Capitula arising near the ends of the branches but not forming dense rounded heads .. .. 16. *nervigera*
        E^5E^5 Leaves often mucronate but not pungent.
          F^3 Leaves small, tightly adpressed .. .. 17. *rugulosa*
          F^3F^3 Leaves well developed, not tightly adpressed.
            G. Leaves excepting when very old with hairs on the lower surface.
              H^1 Leaf with a sharp twist in the lower half, bringing the main part of the leaf into a horizontal position 21. *Muirii*
              H^1H^1 Leaf straight or twisted, if twisted then not as above.
                J^1 Innermost involucral scales glabrous.
                  K^1 Involucral scales acuminate .. .. 22. *phyllostachya*
                  K^1K^1 Involucral scales obtuse, mucronate .. 23. *copholepis*
                J^1J^1 Innermost involucral scales sparingly pilose when young .. .. 24. *Ensorii*
            GG Leaves glabrous or glabrescent on the lower surface.
              H^2 Capitula grouped in compact rounded or oblong heads; individual capitula in most inflorescences only evident on dissection.
                J^2 Outer involucral scales not much shorter than the inner; not or hardly leafy at the tip .. 25. *capitata*
                J^2J^2 Outer involucral scales distinctly shorter than the inner; leafy at the tip.
                  K^2 Prostrate; soft in texture; midrib apparent on lower surface .. .. .. 18. *prostrata*
                  K^2K^2 Erect or spreading; firm in texture; midrib obscure on lower surface.
                    L Corolla lobes spreading abruptly; style branches exceeding the stamens .. 20. *cyathuloides*
                    LL Corolla lobes spreading gradually; style branches shorter than the stamens .. .. 19. *sphaerocephala*
              H^2H^2 Capitula grouped in rather loose heads; individual capitula easily discernible without dissection.
                J^3 Inner involucral bracts obtuse or sub-acute .. 14. *fusca*
                J^3J^3 Inner involucral bracts acuminate .. 15. *humilis*
      D^4D^4 Pappus absent.
        E^6 Leaves tightly adpressed.
          F^4 Leaves ovate; heads from 5 to 10 mm. in diam. .. .. 30. *Schultzii*
          F^4F^4 Leaves lanceolate; heads about 3 mm. in diam. .. 31. *Salteri*
        E^6E^6 Leaves not adpressed.
          F^5 Leaves sharply mucronate .. .. 28. *bruniades*
          F^5F^5 Leaves blunt at the apex .. .. 29. *montana*
    C^4C^4 Inner involucral scales white or cream; corolla lobes narrow, erect.
      D^5 Pappus bristles 5 .. .. 32. *gomphrenoides*
      D^5D^5 Pappus bristles more than 5.
        E^7 Leaves minute, adpressed .. .. 33. *microphylla*
        E^7E^7 Leaves not as above .. .. 34. *leucocephala*

1. Stoebe cryptophylla Baker in Journ. Linn. Soc. XXII, p. 494 (1887). *S. biotoides* Baker, l.c.

A much branched shrub with a stiff habit, 2-3 m. high. Young branches completely hidden by the numerous leaves. *Leaves* linear, about 2 mm. long, adpressed, round-backed, sub-acute, somewhat woolly below when young, becoming more or less glabrous with age; densely woolly above. *Capitula* borne singly at the apex of short shoots arising towards the ends of the main branches. Lower leaves of the fertile shoot green, gradually becoming brown and scarious. Innermost

involucral bracts about as long as the floret, acute or sub-acute. *Pappus* of about 16 bristles, joined at the base, a little shorter than the corolla. *Corolla* narrow, tubular, about 3 mm. long with small triangular teeth which reflex slightly at maturity. *Style branches* far exceeding the corolla when mature. *Style* slightly swollen at the base, without a disc. *Achene* 5-ribbed, somewhat rough.

Flowering season. July to October.

Habitat. Mountain slopes at high altitudes.

MADAGASCAR. Barron 3349! 3504! Perrier de la Bathie 2773! 14416! 16344! Humbert 3836! 6159!

2. STOEBE PACHYCLADA Humbert Comp. Madag. in Mem. Soc. Linn. Normand. XXV. (1923.)

A much branched shrub up to 3 m. high. Branches closely leafy, covered with short, rather coarse hairs when young. *Leaves* canoe-like, the concave side uppermost, narrowed and more or less horizontal at the base, turning abruptly upwards and running obliquely parallel to the stem, not adpressed, about 3 mm. long, glabrous below, canescent above. *Capitula* borne singly on rather short axillary branches grouped towards the apex of the main stems, transition from green leaves to bracts gradual, innermost bracts acute, about as long as the floret. *Pappus* of about 16 bristles, slightly joined at the base, a little shorter than the corolla. *Corolla* narrow, tubular, about 4 mm. long, with small, triangular teeth which bend outwards slightly at maturity. *Style branches* projecting far beyond the corolla at maturity ; style with a slight swelling at the base but without a disc. *Achene* with 5 ribs, papillose-scabrid between the ribs.

Flowering season. November to December.

Habitat. Mountain slopes at altitudes between 2,000 m. and 2,500 m.

MADAGASCAR : Perrier de la Bathie 2783! Humbert 3835!

3. STOEBE PASSERINOIDES Willd. Sp. Pl. iii. p. 2408 (1804). *Stoebe paniculata* Cass. Dict. Sci. Nat. LI., p. 63 (1816-1830). *Seriphium passerinoides* Lam. Dict. I, p. 271 (1791). Less Syn. Comp., p. 345 (1832). DC. Prod. VI, p. 261 (1837).

A much branched shrub, about 2 m. high. Shoots of one type only on the purely vegetative parts, but the capitula arise at the apex of numerous specialised, short shoots. *Leaves* of the vegetative shoots erect, linear-subulate, from 2-4 mm. in length, somewhat keeled on the lower surface, involute, mucronate but sometimes obscurely so, densely woolly above, villous below when young but soon becoming glabrous,

except at the base. Leaves of the short floral shoots much smaller, obtuse and adpressed but otherwise similar to the leaves of the main shoots. *Capitula* borne singly at the ends of specialised shoots, transition from green leaves to bracts gradual, innermost bracts light brown, scarious, about as long as the floret. *Pappus* of about 18 bristles, slightly joined at the base, a little shorter than the corolla. *Corolla* tubular, widening very slightly from the base upwards, with small erect, triangular teeth, a little over 3 mm. in length, purplish brown in colour. *Style branches* longer than the corolla at maturity. *Style* style hardly swollen at the base and without a disc. *Achene* 5-ribbed, scabrid.

Flowering season. April to July.

Reunion. M. G. de l'Isle 389 ! Gaudichaud! Giraudy! Commerson! Boivin! Arnott ! I. B. Balfour!

4. Stoebe kilimandscharica O. Hoffm. in Engl. Pflanzenw. Ost. Af. p. 411 (1895). *Stoebe elgonensis* Mattf. in Notizbl. Bot. Gart, Berlin VIII, p. 236 (1922).

A much branched shrub or small tree, sometimes reaching a height of 6 m. Branches villous when young, becoming less hairy with age, with short shoots arising in the axils of the leaves on the main shoots so that the leaves usually appear tufted. *Leaves* linear, involute, those on the main branches up to 5 mm. in length (frequently shorter), those on the short shoots smaller, mucronate, more or less villous below, with matted wool above. *Capitula* in small groups in the axils of the leaves towards the ends of the branches, produced in large numbers. *Involucral bracts* in several rows, the outermost leafy, gradually becoming brown or yellow in colour and scarious, the innermost about as long as the floret, acute or obtuse. *Pappus* of 14-16 bristles, joined at the base, slightly shorter than the corolla. *Corolla* narrow, tubular, with small, erect, triangular lobes, about 3 mm. long, brownish yellow or purple in colour. *Style branches* much exserted at maturity. *Style* swollen at the base, without a glandular disc. *Achenes* with 5 well marked ribs, scaberulous especially in the upper part.

Flowering season. Plants have been found in flower at various times of the year.

Habitat. Mountain slopes at high altitudes.

Nyassaland : Kyimbila, Stolz 1283! Tanganyika : Mount Meru, Burtt 4078! Oldeani Volcano, Burtt 4230! Loolmalassin mountain, Burtt 4206! Olomoti Crater, Burtt 4393! Njombe, Lynes D.71! Upper Ruhudje, Schlieben 731! Kenya : Mount Kenya, Alluaud 224! Hutchins 392! R. and Th. Fries 1312! Kilimandjaro, Alluaud 319! Mount Elgon, Snowden 803! Liebenberg 1662! Dümmer 3532! Mrs.

Lugard 315! BELGIAN CONGO: Mountains to the West of Lake Kivu, Humbert 7582!

5. STOEBE VULGARIS Levyns sp. n. *Frutex* ramosus, erectus vel expansus. *Folia* ericoidea, gracilia, saepe pungentia, axillis folioliferis. *Capitula* numerosa, in glomerulis. *Bracteae* interiores acuminatae. *Pappi setae* circiter 12. *Corolla* tubulosa, segmentis parvis, triangulatis, erectis. *Achenia* 5-costata.

A much branched grey shrub, usually under 1 m. but may reach 1·5 m. in height. Stems more or less woolly, bearing short shoots, in the axils of the leaves. *Leaves* of the main axes patent, slender, subulate, straight or very slightly twisted, often pungent, acuminate or obtuse, involute, 3 mm. in length or less, densely woolly above, cobwebby or almost glabrous below. Leaves of the short shoots usually about half the length of the main leaves, blunt or slightly mucronate. *Capitula* grouped in small heads in the axils of the upper leaves forming a simple, spike-like or branched inflorescence. *Involucral bracts* in several rows, the outermost short and leaf-like, the innermost brown, scarious, acuminate, longer than the florets. *Pappus* of about 12 bristles, slightly joined at the base, as long as the corolla. *Corolla* narrow, tubular, with small, erect, triangular teeth, about 2 mm. long, brownish in colour. *Style branches* exceeding the corolla when mature. *Style* without a basal disc. *Achene* 5-ribbed, scabrid. The type is C. E. Moss 2850.

Flowering season. March to May.

CAPE PROVINCE: ELLIOT, Cala, Pegler 1743! BASUTOLAND: Leribe, Dieterlen 885! Morija, Page (15974 in Bolus Herb.). TRANSVAAL: Vereeniging, Burtt Davy 15237! Mooi River, Burke! Middleburg, Hewitt! Lydenburg, Wilms 748! Johannesburg, Moss, 2850! Potchefstroom, J. M. McLea 127! Turffontein, Bryant D.14! Potgietersrust, Galpin 9004! Barberton, Galpin 576! Gezina, C. A. Smith 198! Pretoria, Burtt Davy 2381! NATAL: Giant's Castle, Symons 5! Drakensberg, Medley Wood 6310! Dumisa, Rudatis 1127! RHODESIA: Trias Hill, Mundy 3194! Inyanga, Eyles 3562!

6. STOEBE PLUMOSA Thunb. Prod., p. 169 (1800). *Stoebe fasciculata* Cass. in Dict. Sci. Nat. LI., p. 62 (1816-1830). *Stoebe cinerea* Thunb. var. *plumosa* (Less) Harv. Fl. Cap III p. 284 (1865). *Stoebe virgata* Thunb. Prod., p. 170 (1800). *Seriphium plumosum* Linn. Sp. Pl., p. 928 (1753). DC. Prod. VI, p. 262 (1837). *Seriphium cinereum* L. var. *plumosum* Less. Syn. Comp. p. 350 (1832). *Seriphium vermiculatum* DC. Prod. VI, p. 263 (1837). *Seriphium plumosum* L., var. *glabriusculum* DC. Prod. VI, p. 263 (1837).

A shrub, varying in height from 30 cm. to 1·5 m., branching erect or divaricate. *Stem* usually woolly, sometimes densely so, short shoots developed in all leaf axils of the main shoots forming small tufts with a granular appearance. *Leaves* minute, those of the main stems ovate or sharply triangular, slightly concave above or involute, with the apex incurved, obtuse, frequently with a short mucro but occasionally this develops into a spine-like point, usually woolly, rarely almost glabrous; leaves of the short shoots usually oblong and grain-like, without a mucro. *Capitula* grouped in small heads in the axils of leaves towards the ends of the main shoots, sometimes forming a spike-like inflorescence but more often the inflorescence is branched. *Involucral bracts* in several rows, the outermost small and like the leaves, the innermost brown, scarious, sharply acute and a little longer than the corolla. *Pappus* of about 12 bristles, slightly joined at the base, as long as or a little shorter than the corolla. *Corolla* tubular, with small erect, triangular lobes, about 2 mm. long or less, purple or brown in colour. *Style branches* far exserted from the corolla at maturity. *Style* without a basal disc. *Achene* 5-ribbed, scabrid.

Flowering season. Chiefly April to May, but certain forms flower in the Spring, and occasionally plants may be found in flower at other times.

Angola: Near Humpata, Pearson 2788! South West Africa: Auas Mountains, J. Rennie (Levyns 1982)! Lichtenstein, Dinter 3513! 4674! Van Rhynsdorp: Giftberg, Phillips 7398! Clanwilliam: Cederberg, Levyns 2986! near Citrusdal, Levyns 4781! 4782! Ceres: Eland's Kloof, Levyns 4882! 4905! Cold Bokkeveld, Levyns 2408! Laingsburg: Top of Witteberg, Compton 2972! Worcester: du Toit's Kloof, Drege! Matroosberg, Levyns 970! Bain's Kloof, Levyns 5047! Tulbagh: Great Winterhoek, E. P. Phillips (11226 in South African Museum), Bolus 5078! Malmesbury: Riebeek Kasteel, Ecklon! Paardeberg, Pillans 6324! Cape: Flats near Rondebosch, Burchell 733! Pappe! near Cape Town, Bolus 4757! Claremont, Wolley Dod 2613! Simon's Bay, MacGillivray 605! Cape Point, Baker 778! Stellenbosch: Zeyher! between Sir Lowry's Pass and Jonker's Hoek, Burchell 8297! Sir Lowry's Pass, Ecklon 497! Caledon: Kleinriviersberg, Ecklon 498! between Palmiet and Steenbras rivers, Pappe! Between Houw Hoek and Palmiet River, Burchell 8160! Bredasdorp: The Poort, Levyns 4463! Knysna: Burchell 5461! Uniondale: Langekloof, Burchell 4947! Port Elizabeth: Cooper 1479! Albany: Grahamstown, Glass 332! East London: Rattray 1376!

7. STOEBE BURCHELLII Levyns sp. n. *Frutex* ramosus, erectus. *Folia* minima, obtusa, viridia, glabra, subcarnosa, axillis folioliferis. *Capitula* numerosa, in glomerulis, parvis foliis intermixtis. *Bracteae* interiores acutae. *Pappi setae* circiter 12. *Corolla* tubulosa, segmentis parvis, triangulatis, erectis. *Achenia* 5-costata.

A much branched, erect shrub, reaching a height of 1·5 m., green in colour. *Stems* shortly woolly, with short shoots in the axils of the leaves. *Leaves* minute, under 1 mm. in length ; leaves on the main shoots deltoid, fleshy, slightly gibbous at the base, concave above, obtuse, green and glabrous on the lower surface. Leaves on the short shoots smaller than those on the main shoots, granular in appearance. *Capitula* numerous, borne singly or in small groups in the axils of the main leaves. *Involucral bracts* in several rows, the outermost similar to the leaves of the short shoots, the innermost scarious, brown, acute, a little longer than the corolla. *Pappus* of about 12 bristles, slightly joined at the base, about as long as the corolla. *Corolla* tubular with small, erect, triangular lobes, purplish brown in colour, about 2 mm. long. *Style branches* exserted from the corolla, reflexed when mature. *Style* slightly swollen at the base without a disc. *Achene* with 5 ribs, scabrid.

Flowering season. February to June.

The type is C. E. Moss 5382.

ROBERTSON : Montagu, C. E. Moss 5382 ! LAINGSBURG : Witteberg, near Matjesfontein, Rehmann 2931 ! Compton 2504 ! PRINCE ALBERT : Zwartberg Pass, Levyns 5036 ! UNIONDALE : Between Avontuur and Uniondale, Fourcade 2097 ! Langkloof, Burchell 4886 ! Levyns 3802 !

8. STOEBE CINEREA Thunb. Prod. p. 169 (1800) *Stoebe cinerea* Thunb. var. *cinerea* Harv. Fl. Cap. III, p. 284 (1865). *Seriphium cinereum* Linn. Sp. Pl. p. 928 (1753). *Seriphium cinereum* L. var. *cinereum* Less. Syn. Comp. p. 350 (1832).

A branched shrub which may reach 1·5 m. in height. *Stems* usually somewhat woolly, rarely glabrous, with short shoots in the axils of many of the leaves. Leaves on the short shoots smaller than those on the main axes and not conspicuous. *Leaves* ericoid, twisted, squarrose, with a distinct swelling at the base of the midrib on the lower surface, sharply mucronate, rarely more than 5 mm. in length usually less, slightly woolly or glabrous on the lower surface, densely woolly above. *Capitula* grouped in small heads in the axils of the upper leaves, forming a long spike-like inflorescence in which the individual heads are easily discernible. *Involucral bracts* in several rows the outer leaf-like and woolly, the inner brown, scarious, the innermost with long acuminate points, longer than

the floret. *Pappus* of about 12 bristles, a little shorter than the corolla. *Corolla* tubular with small, erect, triangular teeth, about 2 mm. in length, brown or purple in colour. *Style branches* much exserted when mature. *Style* without a basal disc. *Ovary* faintly ribbed with well-marked, transverse lamellae on the upper part. *Achene* 5-ribbed, scabrid.

Flowering season. Usually April—May. An exceptional plant was recorded in flower in September.

Paarl : Klein Drakenstein Mountains, Galpin 11038! FrenchHoek, C. A. Smith 2642! Cape : Table Mountain, Ecklon 501! Prior! Krebs! Woolley Dod 1039! Pappe! MacOwan 1007! Tyson 2375! Devil's Peak, Bolus 3962! between Cape Town and Newlands, Burchell 482! Wynberg, Burchell 859! between Wynberg and Constantia, Burchell 805! between Hout Bay and Wynberg, Drege! Kalk Bay, Levyns 4240! Stellenbosch : Sir Lowry's Pass, Burchell 8189! Caledon : Palmiet River Mouth, Levyns 5392! Genadendal, Levyns 4854! 4842!

9. Stoebe incana Thunb. Prod. Pl. Cap. p. 169 (1800). Thunb. Fl. Cap. ed. Schultes, p. 725 (1823). Less. Syn. Comp, p. 348 (1832). DC Prod. VI, p. 260 (1837). Harv. Fl. Cap. III, p. 283 (1865) *Stoebe leiocarpa* Sch. Bip. in Flora XXVII, p. 694 (1844).

A branched shrub, albo-tomentose or grey-green in colour, maximum height about 50 cm. *Leaves* usually slender, rarely more than 6 mm. long, frequently less, spirally twisted and squarrose, ranging from densely woolly to almost glabrous, but always with some wool when young. *Capitula* massed in rounded or oblong heads. *Involucral scales* in few rows, the outer much shorter than the inner and somewhat like the leaves, the inner brown, sharply acuminate, longer than the florets. *Pappus* of about 14 bristles, slightly joined at the base, a little shorter than the corolla tube. *Corolla* tubular with small, erect, triangular lobes, about 2·5 mm. in length and about 8 mm. wide, dull purple in colour. *Style branches* much exserted from the corolla when mature. *Style* slightly swollen at the base but without a basal disc. *Ovary* either glabrous or hairy, often both found together in the same head. *Achenes* more or less hairy, faintly ribbed.

Flowering season. February—May.

Paarl : MacOwan 838! Stellenbosch : Ecklon! Cape : Table Mountain, Ecklon and Zeyher! Burchell 596! Drege! Harvey! Schlechter 283! Levyns 4245! 4243! 4248! between Table Mountain and Lion's Mountain, Krauss! near Cape Town, Bolus! Muizenberg, Wolley Dod 2530! Kalk Bay, Levyns 4246! 4247! Simon's Bay, Prior! Smitswinkel Bay, Salter 280/7! 280/7a! Caledon : Palmiet River, Ecklon! Viljoen's Pass, Levyns 3909! Buffels Mountain near Rooi Els, Pillans 8182!

Note.—In the past this species has frequently been confused with *S. spiralis* Less. It may be distinguished from that species by its relatively shorter and broader corolla, its longer pappus and its brown, not yellow, involucral bracts.

10. STOEBE SPIRALIS Less. Syn. Comp. p. 347 (1832). *Stoebe spiralis* Less var. *flavescens* Harv. Fl. Cap. III, p. 283 (1865). *Stoebe filaginea* Sch. Bip. in Pollichia XVIII—XIX, p. 179 (1861). *Seriphium flavescens* DC Prod. VI, p. 263 (1837). *Seriphium filagineum* DC Prod. VI, p. 263 (1837).

A branched shrub, reaching 50 cm. in height, usually grey-green in colour but occasionally white owing to the copious development of wool. *Leaves* slender, rarely over 6 mm. in length, spirally twisted, squarrose. *Involucral bracts* in few rows, the outer much shorter than the inner, somewhat leaf-like and woolly, the inner yellow, acuminate, as long as or a little shorter than the mature floret. *Pappus* of about 14 bristles, slightly joined at the base, much shorter than the corolla tube. *Corolla* narrow, tubular with small, erect, triangular teeth, about 3 mm. long and about 0·5 mm. wide, light brown or yellow in colour. *Style branches* much exserted from the corolla when mature. *Style* slightly swollen at the base, but without a basal disc. *Ovary* usually more or less hairy. *Achenes* hairy with very faint ribs.

Flowering season. March—May.

CERES : Eland's Kloof, Levyns 4892! Skurfdebergen, Primos (45696 in South African Museum)! Michell's Pass, C. A. Smith 2700! TULBAGH : Great Winterhoek, Galpin 12586! WORCESTER : Du Toit's Kloof, Drege! Waaihoek, Barnard (45668 in South African Museum)! Bain's Kloof, Salter 373/3! PAARL : Klein Drakenstein, Galpin 10619! STELLENBOSCH : Mundt and Maire! Sir Lowry's Pass, MacOwan 117! Thoday (15878 in Bolus Herb.)! CALEDON : Between Houw Hoek and Palmiet River, Burchell 8166! Between Palmiet River and Sir Lowry's Pass, Burchell 8183! Houw Hoek, Schlechter 7777! Mountains of Baviaans Kloof, Burchell 7617! Levyns 4853! RIVERSDALE : Muir 2511! LADISMITH : Seven Weeks' Poort, Marloth 2948! MOSSEL BAY : Robinson Pass, Pocock (Levyns 4968)!

Note.—The yellow colour of the bracts appears to be lost with age, a fact that must be borne in mind when dealing with herbarium specimens. In the field no colour other than bright yellow has been observed. Fortunately good characters of pappus and corolla serve to separate this species from the closely-related *S. incana*.

11. Stoebe intricata Levyns sp. n. *Frutex* ramosissimus, intricatus. *Folia* oblongo-lanceolata, plerumque adpressa, supra dense albo-lanata, infra leviter araneosa vel glabra, glandulosa, axillis nudis. *Capitula* numerosa in glomerulis parvis. *Bracteae* interiores acutae. *Pappi setae* circiter 20. *Corolla* tubulosa, segmentis parvis, triangulatis, erectis, purpurea. *Achenia* glabra, costis 10, haud prominentibus.

An intricately branched shrub about 1 m. in height. *Stems* woolly with numerous stalked glands, not differentiated into long and short shoots, branches arising at a wide angle. *Leaves* mostly adpressed, oblong lanceolate, up to 3 mm. long, concave above, obtuse and slightly hump-backed, somewhat cobwebby or almost glabrous on the lower surface, with few or many sessile or almost sessile glands. *Capitula* in numerous small groups, both lateral and terminal. *Involucral bracts* in several rows, the outer bracts short leafy and glandular, woolly or almost glabrous ; the inner bracts brown, scarious, acute, equalling or slightly shorter than the florets. *Pappus* of about 20 bristles, slightly joined at the base, equalling the corolla. *Corolla* tubular, with small, erect, triangular lobes which reflex slightly on the extrusion of the style branches, about 3 mm. long, deep purple. *Style branches* far exserted at maturity. *Style* swollen at the base but without a glandular disc. *Achene* smooth with about 10 inconspicuous ribs.

Flowering season. April—July.

The type is Levyns 5034.

Ceres : Eland's Kloof in the Cold Bokkeveld, Levyns 4888! 4900! 4906! Worcester : Hex River Pass, Levyns. Robertson : Levyns 5512! Riversdale : Muiskraal, Levyns 2122 ! Ladismith : Seven Weeks' Poort, Levyns. Prince Albert : Pocock S.180! Levyns 5034!

12. Stoebe saxatilis Levyns sp. n. *Frutex* parvus, ramosus. *Folia* linear-lanceolata, conferta, incurva, sed non adpressa, lanata. *Capitula* in glomerulis parvis ad apicem ramulorum vel in axillis. *Bracteae* interiores acutae. *Pappi setae* circiter 20. *Corolla* tubulosa, purpurea, segmentis parvis, triangulatis, erectis.

A low branched shrub, 60 cm. high or less. Branches woolly when young, becoming more or less glabrous with age, not differentiated into long and short shoots. *Leaves* linear-lanceolate, about 2·5 mm. in length, incurved, closely and somewhat obliquely set the whole branch thus giving the impression of a chain, densely woolly on both surfaces. *Capitula* in rather small groups towards the ends of the branches, either

terminal or lateral. *Involucral bracts* in few rows, the outer short and similar to the leaves, the inner scarious, acute, about equalling the floret. *Pappus* of about 20 bristles, slightly joined at the base, about as long as the corolla or a little shorter. *Corolla* tubular, with small erect, triangular lobes which reflex slightly on the extrusion of the style branches, about 3 mm. long, purple. *Style branches* exserted and reflexed at maturity. *Style* swollen at the base, without a glandular disc. *Ovary* glabrous and faintly ribbed. *Achene* not seen.

Flowering season. April—May.

The type is Levyns 4910.

CERES : Eland's Kloof, Cold Bokkeveld, Levyns 4894! 4901! 4910! 4922! WORCESTER : Chavonnesberg, Galpin 12744!

Note.—This species appears to be characteristic of high altitudes from 3,500 to 5,000 feet, and is most frequently found in rock crevices.

13. STOEBE ALOPECUROIDES Less. Syn. Comp. p. 349 (1832) DC. Prod. VI, p. 260 (1837). Harv. in Fl. Cap. III, p. 284 (1865). *Seriphium alopecuroides* Lam. Encyc. i, p. 271 (1791).

A robust erect shrub up to 1·5 m. in height. Main axes covered with rather shaggy hairs, giving off numerous short lateral branches bearing crowded leaves. *Leaves* ericoid, spirally twisted, pungent, mucronate, usually under 1 cm. in length, glabrous or canescent on the lower surface. *Capitula* densely crowded in terminal spikes 5—15 cm. long and 15—20 mm. broad, with foliage leaves apparent between the groups of capitula. *Involucral bracts* in few rows, the outer much shorter than the inner, green tipped, woolly, obtuse, the inner scarious and brown, glabrous or hardly woolly, sharply acute. *Pappus* of about 16 free bristles, slightly longer than the corolla tube. *Corolla* with well developed, spreading, triangular lobes, white. *Style branches* almost reaching the tips of the corolla lobes when mature. *Style* not swollen at the base, without a basal disc. *Ovary* with 5 wing-like ribs which may show serrations in the upper part. *Achenes* with about 10 well-marked ribs, serrated in their upper portion.

Flowering season. July—December.

RIVERSDALE : Garcia's Pass, Thorne (38958 in the South African Museum)! MOSSEL BAY : Cloete's Pass, Muir 1073! GEORGE : Rogers 4296! Jonkersberg, Rendle 162! near Kayman's River, Burchell, 5770! 5795! Levyns 787! 4973! Knysna, Bowie! Bolus 2105! Newdigate (6092 in South African Museum)!. Kapp 74! Millwood, Tyson 1474! Plettenberg Bay, Rogers 27882! PRINCE ALBERT : Zwartberg Pass, Bolus 11539! UITENHAGE : Zwartkops River, Pappe! WITHOUT PRECISE LOCALITY : Niven! Shantz!

14. Stoebe fusca Thunb. Prod. Pl. Cap. p. 170 (1800). Harv. in Fl. Cap. III, p. 283 (1865). *Seriphium fuscum* Linn. Sp. Pl. p. 928 (1753). Less. Syn. Comp. p. 351 (1832). DC. Prod. VI, p. 262 (1837).

A small, much branched shrub, up to about 30 cm. in height. Stems covered with a grey, cobwebby indument. *Leaves* ericoid, spirally twisted, from 1—8 mm. long, lower surface cobwebby when young, glabrescent, mucronate or obtuse. *Capitula* distinct, grouped in terminal heads which are usually oblong but may be rounded. *Involucral bracts* in several rows, the outermost short, green or woolly, the inner longer, scarious, light brown, obtuse or sub-acute, a little exceeding the corolla tube in length. *Pappus* of about 18 bristles, as long as or longer than the corolla tube. *Corolla* pink or white, with spreading lobes. *Style branches* shorter than the corolla lobes. *Style* swollen at the base and seated on a waxy disc. *Achene* 5 ribbed, covered with adpressed, shaggy hairs.

Flowering season. March—May.

Clanwilliam : Pakhuis Pass, le Roux! Ceres : Eland's Kloof, Cold Bokkeveld, Levyns 4880! 4921! Paarl : Cummings! Malmesbury : Near Moorreesburg, Pillans, 6802! Cape : Devil's Mountain, Pappe! Flats, Drege! Cape Town, Burchell 922! Wynberg, Burchell 885! Bolus! Lion's Head, Pillans 6175! Camps Bay, Pappe! Hout Bay, Wolley Dod 950! Schlechter 7211! Chapman's Peak, Levyns 4970! Silvermine Valley, Salter 2057! Simon's Town, Wolley Dod 942! Dr. Kirks! Mrs. Jameson! Stellenbosch : Somerset West, Drege! Sir Lowry's Pass, Burchell 8241! Caledon : Houw Hoek, Schlechter 7560! Caledon, Bolus 9904! near top of Shaw's Mountain, Levyns 3531! Bredasdorp : Schlechter 10537!

Without precise locality : Ecklon and Zeyher! Bowie! Grey! Mund! Forster! Lambert!

15. Stoebe humilis Levyns sp. n. *Suffrutex* humilis, parce ramosus. *Folia* linearia, involuta, mucronata, base erecto-adpressa, patentia, supra torta. *Capitula* in glomerulis laxis, terminalibus. *Bracteae* interiores acuminatae. *Pappi setae* circiter 15. *Corolla* alba, segmentis triangulatis, patentibus. *Styli* base in disco cereo sedentes.

A low undershrub, up to 15 cm. high with leafy branches. *Stems* cobwebby when young. *Leaves* linear, about 6 mm. long, strongly involute, mucronate, erect adpressed at the base, but patent and twisted

for over two-thirds of the total length, glabrous below, white woolly above. *Capitula* grouped in loose, terminal heads, rarely exceeding 1 cm. in diam., usually less. *Involucral bracts* in several rows, the outer about one-third the length of the inner, leaf-like and cobwebbed, the inner scarious, glabrous, acuminate, equalling or a little shorter than the corolla. *Pappus* of about 15 rather stout bristles, not or hardly joined at the base, about the same length as the corolla. *Corolla* white, about 4 mm. long, with spreading lobes about one quarter the length of the corolla. *Style branches* not exceeding the corolla lobes. *Style* with a swollen base, seated on a waxy disc. *Ovary* glabrous. *Achene* glabrous or slightly puberulous.

Flowering season. January—February.

CALEDON : Palmiet River Mouth, Levyns 5369! (the type).

16. STOEBE NERVIGERA Sch. Bip. in Pollichia XVIII—XIX, p. 183 (1861). Harv. in Fl. Cap. III, p. 281 (1865). *Seriphium nervigerum* DC. Prod. VI, p. 263 (1837). *Seriphium nervigerum* DC. var. *squarrosum* DC. Prod. VI, p. 263 (1837).

A small stiffly branched shrub about 30 cm. high. *Stems* woolly when young. *Leaves* imbricate, erect or recurved, linear subulate, pungent mucronate, involute, glabrous on the lower surface with a prominent midrib and two conspicuous, lateral, parallel veins at the base of the leaf, the latter forming the thickened margin in the upper part of the leaf, pitting in between the veins obvious in dried specimens, obscure when fresh. *Capitula* grouped at the ends of the branches in the axils of leaves, individual capitula distinct. *Involucral bracts* in several rows, the outer shorter, somewhat leaf-like, the inner longer, light straw-coloured, stiff, taper-pointed, almost as long as the floret, sometimes reaching 8 mm. in length. *Pappus* of about 18 stiff, well developed bristles, almost as long as the corolla. *Corolla* white, rarely purple, with narrow, slightly spreading lobes. *Stamens* as long as the corolla. *Style* slightly swollen at the base, seated on a waxy disc. *Achene* glabrous, with very faint, broad ribs, slightly rugose between the ribs.

Flowering season. January—July.

VAN RHYNSDORP : Between Heerenlogement and Knaga Berg, Drege! CLANWILLIAM : Olifant's River, Zeyher! WORCESTER : Hex River, Bolus 5964! Near Worcester, Rehmann 2619! Between Worcester and Cogman's Kloof, Bolus 8097! CALEDON : Zoutmelks Valley, Burchell 7570! Genadendal, Burchell 7826! Levyns 4865! Greyton, Gillett 879! BREDASDORP : Schlechter 7668! RIVERSDALE : Albertinia, Muir 1352!

17. Stoebe rugulosa Harv. in Fl. Cap. III, p. 282 (1865).

Small shrub with thin whip-like branches, about 40 cm. in height. *Stems* covered with white wool when young, becoming more or less glabrous later. *Leaves* small, rarely more than 2 mm. in length, adpressed, imbricate, linear-subulate with a short mucro, glabrous on the lower surface with three parallel veins which are not prominent, pitted in between the veins. *Capitula* grouped at the ends of the branches in the axils of the leaves, individual capitula distinct. *Involucral bracts* in several rows, the outer shorter and somewhat leaf-like, the inner scarious, mostly obtuse, rarely sub-acute, a little longer than the corolla tube, about 3 mm. in length. *Pappus* of about 18 bristles, a little shorter than the corolla. *Corolla* pink, with rather narrow, spreading lobes. *Stamens* as long as the corolla. *Style* slightly swollen at the base, seated on a disc. *Ovary* with a minutely toothed, cup-like annulus, minutely puberulous. *Achene* not seen.

Flowering season. March to May.

Swellendam: Breede River, Mund! Riversdale: Albertinia, Muir 1999! Oakdale, Muir 2544! Without Locality: Marloth 8089!

18. Stoebe prostrata Linn. Mant. ii, p. 291 (1771). Thunb. Prod., p. 169 (1800). Thunb. Fl. Cap. ed. Schultes, p. 726 (1823). Harv. in Fl. Cap. III, p. 281 (1865) *Seriphium prostratum* Lam. Dict. I, p. 273 (1791). Less. Syn. Comp., p. 351 (1832). DC. Prod. VI, p. 265 (1837).

Small plant of prostrate habit. *Stems* slender, slightly woody, cobwebby when young. *Leaves* linear-oblong, mucronate, flat or somewhat involute, twisted near the base, midrib evident on the glossy lower surface. *Capitula* grouped in rounded, terminal heads, about 1 cm. in diam. *Involucral bracts* in few rows, the outer hairy and green-tipped, the inner scarious, sharply acute, slightly longer than the corolla tube. *Pappus* of about 18 fine bristles, about as long as the corolla tube. *Corolla* pink, the lobes triangular spreading. *Style* swollen at the base and seated on a waxy disc. *Achene* with 5 well marked ribs, covered with adpressed hairs.

Flowering season. January to February.

Cape: Table Mountain, Burchell 649! Drege! Harvey! Bolus 139! Bolus 4913! Wolley Dod 855! Salter 280/5! J. D. C. Lamb, 3205! Orange Kloof, W. Jacobsen (50674 in South African Museum)! Zwart Kop, Salter! Paarl: French Hoek, Schlechter 10263! Caledon: Top of mountain at Genadendal, Burchell 7769!

Note.—This species is characteristic of high altitudes. It is a common plant from the Lower Plateau to the top of Table Mountain.

19. STOEBE SPHAEROCEPHALA Schlecht. in Engl. Jahrb. XXVII, p. 202 (1900).

Plants with erect or procumbent habit, somewhat rigid. *Stems* cobwebby when young, almost glabrous later except at the nodes. *Leaves* variable in size, from 5-15 mm. in length, linear or oblong, mucronate, twisted near the base, lower surface glabrous or slightly woolly when young, midrib not apparent. *Capitula* grouped in rounded, terminal heads with foliage leaves projecting here and there, usually a little more than 1 cm. in diam. *Involucral bracts* in few rows, the outer shorter, somewhat leafy and woolly, the inner about as long as the floret, scarious, acute. *Pappus* of about 18 bristles, about as long as the corolla tube. *Corolla* with spreading, oblong lobes which are usually less than half the length of the corolla tube, white or pink in colour. *Style* and its branches when mature, shorter than the stamens; style swollen at the base, seated on a waxy disc. *Achene* with 5 inconspicuous ribs, covered with upwardly directed hairs which absorb moisture readily.

Flowering season. November to February.

CAPE: Simonsberg, Wolley Dod 288! Boonberg, Pillans 4918! Redhill, Salter 2928! near Buffels Bay, Salter, 2934! Olifant's Bosch, Levyns 4933! CALEDON: Palmiet River, near Grabouw, Bolus 4145! Mossel River, L. Guthrie! Klein River mouth, Schlechter 9523! Houw Hoek, Schlechter 5056! RIVERSDALE: near Albertinia, Muir 1259! Garcia's Pass, Marloth 3563!

20. STOEBE CYATHULOIDES Schlecht. in Engl. Jahrb. XXVII p. 201 (1900).

Closely allied to *S. sphaerocephala* Schlecht. with which it agrees in its vegetative and many of its floral characters. It differs from *S. sphaerocephala* in (*a*) the linear corolla lobes which are about half the length of the corolla tube, (*b*) the relatively narrow corolla tube and (*c*) the style branches which are longer than the stamens when mature.

Flowering season, December.

BREDASDORP: Rietfontein Poort, Schlechter 9676! Bolus 8552!

Note.—I have retained this species on account of its distinguishing floral features. However, it is known from two collections only, both from the same locality, and it is possible that when further material from the Caledon—Bredasdorp area is available it may be found to be merely a form of what is now known as *S. sphaerocephala*, a species in which slight variability of the corolla lobes has been observed. If at some future time it be found necessary to unite these species then the name *S. cyathuloides* has priority.

21. Stoebe muirii Levyns sp. n. *Frutex* parvus, expansus. *Folia* elliptico-oblonga, mucronata, parce involuta, multo torta et flexuosa, supra tomentosa, infra villoso-tomentosa. *Capitula* in glomerulis densis, oblongis, terminalibus. *Bracteae* interiores acuminatae. *Pappi setae* circiter 19. *Corolla* rosea segmentis triangulatis, patentibus. *Styli* base turgidi, in disco cereo sedentes.

A low, spreading shrub. *Branches* arising at a wide angle, stems densely tomentose. *Leaves* elliptic-oblong, mucronate, slightly involute with a marked twist and bend in the lower part, resulting in the main part of the leaf lying with its midrib more or less horizontal and its lower surface facing outwards, up to 5 mm. long and 2 mm. wide, the lower surface with rather long and loose hairs. *Capitula* massed at the ends of the branches in cylindrical spikes up to 4 cm. in length and 1 cm. in width. *Involucral bracts* in few rows, the outer shorter, woolly, the inner scarious, about as long as the corolla, acuminate. *Pappus* a little longer than the corolla tube, consisting of about 19 bristles slightly joined at the base. *Corolla* with acute, spreading lobes, pink in colour. *Style* with a swollen base, seated on a waxy disc. *Ovary* somewhat scabrid, with faintly marked ribs. *Achene* not seen.

Flowering season. April.

Riversdale: Still Bay, Muir 2399! (The type).

22. Stoebe phyllostachya Sch. Bip. in Pollichia XVIII—XIX, p. 179 (1861). *Stoebe phlaeoides* Sch. Bip. in Pollichia XVIII—XIX, p. 179 (1861). Harv. in Fl. Cap. III, p. 282 (1865). *Stoebe phlaeoides* Sch. Bip. var *phyllostachya* Harv. in Fl. Cap. III p. 282 (1865). *Seriphium phyllostachyum* DC. Prod. VI, p. 262 (1837). *Seriphium phlaeoides* DC. Prod. VI, p. 262 (1837).

A branched shrub, 30 cm. or more in height. *Stems* villous glabrescent. *Leaves* linear-lanceolate, up to 1 cm. in length, varying from almost flat to involute on the same plant, straight or slightly twisted sub-aristate, erect below the inflorescence, spreading elsewhere, loosely villous on the lower surface, sometimes glabrescent, hairs densely matted above. *Capitula* massed in somewhat rounded heads in the axils of the upper leaves which may project beyond the glomerules; whole inflorescence usually oblong, occasionally rounded, dense when the flowers are fully open, variable in size. *Involucral bracts* in few rows the outer not less than half the length of the inner and not wholly leaf-like; outermost bracts with a green midrib, slightly hairy on the back, innermost brown, scarious, acuminate, the longest as long as or a little longer than the

corolla tube. *Pappus* of 12-14 bristles, slightly joined at the base, shorter than or almost equalling the corolla tube. *Corolla* with rather narrow, spreading lobes, the tube about 2·5 mm. long, the lobes about 1 mm. long, white. *Style branches* not exceeding the corolla lobes. *Style* swollen at the base, seated on a waxy disc. *Ovary* glabrous or slightly puberulous, with faintly marked ribs. *Achenes* not seen.

Flowering season. February—April.

SWELLENDAM: Mund 366! Mund 107! Niven! Zuurbraak, Thode A2337! RIVERSDALE: Garcia's Pass, Marloth 3571! UNIONDALE: Langkloof, Burchell 5052! 5131! Many Waters Kloof, Compton 5179!

Note.—Compton 5179 is a more slender form than usual and the heads are rounded instead of oblong. Apart from this there are no important differences. *S. phyllostachya* is closely related to *S. capitata*, a predominantly western species, in which field studies have made it necessary to include plants showing a similar range of variation in one species (see p. 7). Similarly in this instance Compton 5179 has been treated as a slender form of *S. phyllostachya*.

23. STOEBE COPHOLEPIS Sch. Bip. in Pollichia XVIII—XIX, p. 179 (1861).

A small, erect, branched shrub. *Leaves* somewhat adpressed, oblong-lanceolate, convex-backed, with a well developed black mucro, 6-8 mm. in length, densely woolly on the lower surface when young, but the wool tending to disappear with age. *Capitula* in oblong, terminal heads. *Involucral bracts* oblong, obtuse, with a short mucro. *Pappus* of about 12 bristles, slightly joined at the base, equalling the corolla tube in length. *Corolla* with triangular, spreading lobes. *Style* seated on a waxy disc. *Ovary* minutely puberulous.

Flowering season. February to March.

CALEDON: Palmiet River, Ecklon 484! BREDASDORP: near Elim Bolus!

Note.—This species approaches *S. phyllostachya* very closely and it may prove to be a form of that species. Herbarium material is scanty. The specimen collected by Bolus has the imperfect remains of a few flowers only.

24. STOEBE ENSORII Compton, Kew Bull., p. 259 (1934).

Small, spreading or sub-erect shrub. *Leaves* numerous, scattered, imbricate, twisted, sub-patent or erect, oblong-lanceolate, somewhat involute, acute, mucronate, about 3 mm. long, upper surface densely

woolly, the lower surface loosely woolly. *Capitula* massed in globose or cylindrical, terminal heads, up to about 25 mm. long and 12 mm. wide. Involucral bracts in few rows, the outer a little shorter than the inner ; the outermost with a green midrib, pilose ; the innermost brown, scarious, sparingly pilose, acuminate, a little shorter than the floret. *Pappus* of about 12 bristles, united at the base, a little longer than the corolla tube. *Corolla* with spreading, triangular lobes, pink. *Style* with a swelling at the base, seated on a waxy disc. *Ovary* minutely puberulous. *Achene* not seen.

Flowering season. July.

UNIONDALE : Lauterwater, Compton 4195!

25. STOEBE CAPITATA. Berg. Descr. Pl. Cap., p. 338 (1767). Harv. in Fl. Cap. III, p. 283 (1865). *Stoebe Mossii* S. Moore, Journ. Bot. LVIII, p. 76 (1920). *Stoebe affinis* S. Moore, Journ. Bot. LVIII, p. 77 (1920). *Seriphium capitatum* Less. Syn. Comp. p. 252 (1832). DC. Prod. VI, p. 263 (1837). *Seriphium perotrichoides* Less. l.c., DC. l.c.

A branched shrub, 50 cm. high or less, erect or sub-erect. *Stem* cobwebby or somewhat woolly when young. *Leaves* linear-subulate, strongly involute, much twisted, variable in length, from 2-10 mm., sharply mucronate, erect or patent, loosely woolly on cobwebby on the lower surface when young, frequently glabrescent. *Capitula* massed in terminal rounded or oblong heads. *Involucral bracts* not differing greatly in size and texture ; the outermost with a green keel, the innermost scarious, acute or acuminate, as long as or a little longer than the corolla tube. *Pappus* of about 12 bristles, well or poorly developed, as long as the corolla tube or shorter. *Corolla* with well developed, spreading lobes, pink or white. *Style* swollen at the base, seated on a waxy disc. *Ovary* usually covered with numerous, fine, adpressed hairs. *Achene* with rather shaggy hairs.

Flowering season. December to March.

PIQUETBERG : Olifant's River Mountains, Edwards 91! CERES : Rogers 17605! C. A. Smith, 2701 ! WORCESTER : du Toits Kloof, Cummings 311!. TULBAGH : Great Winterhoek, Drege! MALMESBURY : Mamre, Baur 1179! PAARL : Drege! Dal Josaphat, Tyson 884! Bain's Kloof, Schlechter 10244! CAPE : Zeekoe Vallei, Ecklon! Cape Flats, Burchell 709! Princess Vlei, McOwan 1621! Diep River, O. Kuntze! Devil's Peak, Page! Rondebosch, Bolus 3290! Wolley Dod 908! Constantiaberg, Wolley Dod 2262! Hout Bay, Compton! Muizenberg, Caporn! Klaver Valley, Levyns 5522! 5523! Cape Point, Michell!

STELLENBOSCH : Niven! Galpin 10611! Sir Lowry's Pass, Levyns 4861! CALEDON : Steenbras, Moss and Rogers 1583! Elgin, C. A. Smith 2561! 5668! Moss and Rogers 1526! Bot River, Salter 5186! Shaw's Mountain, Levyns 3529! 5401! Hermanus, Marloth 11909! Genadendal, Burchell 7641! Greyton, Levyns 4867! BREDASDORP : Levyns 3526! SWELLENDAM : Mund! RIVERSDALE : Muir 2545! Garcia's Pass, Mrs. Luyt! ALBANY : Round Hill, Bolus 10641!

WITHOUT PRECISE LOCALITY : Roxburgh! Zeyher 909! Harvey 30!

Note.—For a discussion of variability in this species see p. 7.

26. STOEBE AETHIOPICA Linn. Sp. Pl., p. 831 (1753). Lam. III, t. 722 (1791). Thunb. Fl. Cap. ed. Schultes, p. 725 (1823). Less. Syn. Comp., p. 347 (1832). DC. Prod. VI, p. 260 (1837). Harv. in Fl. Cap. III, p. 280 (1865). *Stoebe phylicoides* Thunb. Prod., p. 169 (1800). Thunb. Fl. Cap. ed. Schultes, p. 726 (1823). Less. Syn. Comp., p. 346 (1832). DC. Prod. VI, p. 260 (1837). Harv. Fl. Cap. III, p. 281 (1865). *Seriphium juniperinifolium* Lam. Encycl. I, p. 272 (1783). *Seriphium aethiopicum* Steud. Nom. ed. I, p. 767 (1821).

A shrub, ranging from 40 to 160 cm. in height, the shorter forms being usually copiously branched and the taller forms little branched. *Branches* villous or pubescent, sometimes becoming almost glabrous with age. *Leaves* about 1 cm. long, oblong, subulate-lanceolate or subulate, varying from almost flat and straight to strongly involute, twisted and recurved ; pungent mucronate, woolly above, glabrous or nearly so below. *Capitula* massed in rounded heads, the limit of each capitulum not evident without dissection. The outer *involucral scales* smaller than the inner, somewhat leafy at the tip ; innermost scales scarious, brown-tipped, glabrous or woolly, a little shorter than the floret. *Pappus* of about 18 bristles, slightly joined at the base, shorter than the corolla tube with an external rim of very small scales just outside the bristles. *Corolla* with spreading, triangular lobes, white. *Style* swollen at the base, seated on a waxy disc. *Ovary* glabrous. *Achene* glabrous or nearly so.

Flowering season. September—March (Chiefly September to November).

VAN RHYNSDORP : Giftberg, Drege! E. P. Phillips 7348! 7613! CLANWILLIAM : Nardouw Kloof, Salter 3619! Pillans 7075! Pakhuis Pass, Salter 1671! Levyns 5054! Cederberg, Bolus 14478! Levyns 2226! Ezelsbank, Drege! Kromme Rivier, Bolus 5693! Leighton (21409 in Bolus Herb.)! Boontjes River, Schlechter 8673! Clanwilliam,

Leipoldt! Olifant's River, Marloth 2652! PIQUETBERG : Grey's Pass, Levyns 1369! near Piquetberg, Bolus 8496! CERES : Eland's Kloof, Cold Bokkeveld, Levyns 4917! 5112! TULBAGH : Great Winterhoek, E. P. Phillips 1769! PAARL : French Hoek, E. P. Phillips 1162! STELLENBOSCH : Sir Lowry's Pass, Burchell 8202! Hottentots Holland, Mund 26! CAPE : Constantia, Ecklon! Table Mountain, Ecklon 751! Burchell 614! Drege! Kirstenbosch, Ecklon and Zeyher! Orange Kloof, Wolley Dod 2141! Devil's Peak, MacOwan 545! Camps Bay, Levyns 5298! Claremont, Salter 280/4A! Flats, Wallich 235! Klaver Valley, Salter 280/4B! Simon's Bay, C. Wright! WORCESTER : Matroosberg, E. P. Phillips 1913! Pietermeintjies, Marloth 9975! ROBERTSON : Wilde Paardeberg, Stokoe 2749! CALEDON : Elgin, Levyns 3322! Donker Hoek Mountain, Burchell 7976! SWELLENDAM : Barrydale, Barnard (32715 in South African Museum)! RIVERSDALE : near Zoutmelk's Rivier, Burchell 6664! PRINCE ALBERT : Zwartberg Pass, Bolus 11540! UNIONDALE : Avontuur, Marloth 10958!

WITHOUT PRECISE LOCALITY : Zeyher! Thom! Niven! Harvey 568! Küntze! Forster! Forsyth! Lindley!

Note.—See p. 9 for a discussion of this species.

27. STOEBE ROSEA Wolley Dod in Journ. Bot., p. 399 (1901). *S. Pentheri* O. Hoffmann in Ann. Nat. Hofmus, Wien. XXIV, p. 302 (1910).

A much branched shrub, about 50 cm. high, densely leafy. *Stem* entirely hidden by the leaves when young. *Leaves* ericoid, mucronate, keeled, twisted, patent or slightly reflexed, about 6 mm. long, the lower surface slightly woolly when young, glabrous later. *Capitula* massed in dense, rounded terminal heads. Outer *involucral bracts* shorter than the inner, leafy and woolly at the apex, scarious below ; inner involucral bracts scarious, acute, shorter than the floret. *Pappus* of numerous feathered bristles, each with radial symmetry, united for some distance at the base, about as long as the corolla. *Corolla* cylindrical below, becoming more or less globose above, with short, incurved, triangular lobes, pink in colour. *Style* slightly swollen at the base, disc absent, or minute. *Achene* covered with rather shaggy, upwardly directed hairs.

Flowering season. January to March.

CAPE : Muizenberg, Herm. Bolus! Bolus 3915! N. Pillans 8046 in Bolus Herb.! Penther 1151! Salter 2994! Simonsberg, Wolley Dod 273! Klasjagersberg, Wolley Dod 2417! Klaver Valley, Salter 1945! Redhill, Grey!

28. Stoebe bruniades Levyns nom. nov. *Perotriche tortilis* Cass. in Bull. Soc. Philom., p. 75 (1818). Less Syn. Comp., p. 253 (1832). DC. Prod. VI, p. 264 (1837). Harv. in Fl. Cap. III, p. 285 (1865). *Gymnachaena bruniades* Reichb. in Sieb. Pl. Cap. exs., n. 23.

A low, branched shrub of somewhat spreading habit, up to 40 cm. high. Young stems woolly. *Leaves* linear-subulate, strongly involute, twisted, aristate-mucronate, lower surface cobwebby, glabrescent. *Capitula* massed in dense rounded or oblong heads, at the ends of the branches, up to 8 mm. in diam. *Involucral bracts* in few rows, not very different in length, the outermost slightly shorter, somewhat leafy and woolly, the innermost brown, scarious, mucronate, a little longer than the corolla tube. *Pappus* O. *Corolla* about 2 mm. long, with ovate, spreading lobes, about one third the length of the tube, usually pink, sometimes white in colour. *Style* swollen at the base, seated on a waxy disc. *Ovary* glabrous. *Achene* not seen.

Flowering season. February to April.

Cape: Tygerberg, Salter! Devil's Peak, Pappe! Bolus 7165! Guthrie 973! Levyns 4942! Stellenbosch: Galpin 10611! Caledon: Genadendal, Burchell 7974! near Ganzekraal, Burchell 7562! Caledon, O. Küntze!

Without locality: Ecklon! Harvey!

29. Stoebe montana Schlechter ex Levyns. *Suffrutex* humilis, ramosissimus, expansus. *Folia* linearia, involuta, torta, obtusa. *Capitula* in glomerulis parvis, terminalibus. *Bracteae* interiores sub-acutae. *Pappus* O. *Corolla* rosea, segmentis triangulatis, patentibus. *Styli* base sub-turgidi, in disco cereo sedentes.

A small, much branched undershrub about 12 cm. high, of somewhat spreading habit. *Leaves* about 2 mm. long, linear, involute, twisted, thickened towards the apex, very obtuse; woolly, glabrescent below. *Capitula* in small rounded heads at the ends of the branches, about 5 mm. in diam. *Involucral bracts* in few rows, two or three of the outermost leafy and woolly, the innermost brown, scarious, somewhat acute, as long as the corolla tube. *Pappus* O. *Corolla* 2·5 cm. long with spreading lobes about one quarter the length of the tube, pink in colour. *Style* slightly swollen at the base, seated on a waxy disc. *Ovary* glabrous. *Achene* not seen.

Flowering season. January.

Ceres: Gydouwberg, 5,800 ft., Schlechter 10233! (The type.)

30. Stoebe schultzii Levyns nom. nov. *Perotriche microphylla* Sch. Bip. in Pollichia XVIII—XIX, p. 181 (1861).

A small, branched shrub about 30 cm. high. *Branches* long and whip-like. *Leaves* ovate, under 2 mm. long, adpressed and overlapping closely, somewhat obtuse, with a depression over the midrib on the lower surface, glabrescent on the lower surface. *Capitula* grouped in rounded, terminal heads from 5-10 mm. in diam., each capitulum in the axil of a somewhat leafy bract. *Involucral bracts* usually 3 in number, approximately equal in size, brown, scarious, oblong, obtuse, the outermost most obtuse and with a slightly fimbriate margin. *Pappus* O. *Corolla* 2 mm. in length, with spreading lobes, a little over a third of the length of the tube. *Style* with a swollen base, seated on a waxy disc. *Ovary* about 0·6 mm. long glabrous, narrowed at the base, with a minutely toothed annulus. *Achene* not seen.

Flowering season. October to December.

Bredasdorp: near Elim, Bolus 6910! Swellendam: Zoetendal's Valley, Krauss!

31. Stoebe salteri Levyns sp. n. *Suffrutex* humilis, ramosus. *Caules* flagelliformes. *Folia* lanceolata, adpressa, obtusa vel sub-acuta, infra glabrescentia. *Capitula* in glomerulis terminalibus. *Bracteae* interiores oblongae, obtusae, apice fimbriatae. *Pappus* O. *Corolla* alba, segmentis triangulatis, patentibus. *Styli* base turgidi, in disco cereo sedentes.

A small, branched undershrub, up to 15 cm. high with delicate, whip-like branches. *Leaves* lanceolate, under 2 mm. in length, closely investing the stem but not obscuring it completely, obtuse, or subacute, glabrescent on the lower surface. *Capitula* in rounded heads at the ends of the branches, 3 mm. in diam. *Involucral bracts* in few rows, the outermost leafy and woolly, a little shorter than the inner, the innermost brown, scarious, very obtuse, fimbriate towards the apex, about the length of the corolla tube. *Pappus* O. *Corolla* with a tube about 1 mm. long, the lobes spreading, about 0·5 mm. in length, white in colour. *Style* with a swollen base, seated on a disc. *Ovary* about 0·8 mm. with a minutely toothed annulus, glabrous. *Achene* not seen.

Flowering season. December.

Caledon: $5\frac{1}{2}$ miles South of Caledon, Salter 5149! (the type.)

32. STOEBE GOMPHRENOIDES Berg. Descr. Pl. Cap., p. 336 (1764). Less. Syn. Comp., p. 346 (1832). DC. Prod. VI, p. 259 (1837). Harv. in Fl. Cap. III, p. 280 (1865); not of Thunb. Fl. Cap. ed. Schultes, p. 726 (1823). *Seriphium gomphrenoides* Lam. Encycl. I, p. 272 (1791).

A small, erect shrub not much branched. *Leaves* adpressed, elliptic-oblong, concave, about 1 cm. long, obtuse or mucronulate, glabrous on the lower surface, woolly above, ciliate. *Capitula* massed in rounded terminal heads about 2 cm. in diam. *Involucral bracts* cream, a little shorter than the corolla, somewhat acute. *Pappus* of 5 bristles, a little shorter than the corolla. *Corolla* with narrow, erect lobes. *Style* slightly swollen below and seated on a small disc. *Ovary* glabrous, slightly angled. *Achene* not seen.

Flowering season. November.

CAPE: Doornhoogte, Cape Flats, Ecklon!

WITHOUT CERTAIN LOCALITY: Mund! Bowie!

33. STOEBE LEUCOCEPHALA DC. Prod. VI, p. 259 (1837). Harv. Fl. Cap. III p. 280 (1865). *Stoebe squarrosa* Harv. Fl. Cap. III, p. 280 (1865). *Wigandia leucocephala* Sch. Bip. in Pollichia, p. 180 (1861).

An erect or diffuse undershrub. *Branches* canescent. *Leaves* up to 15 mm. long narrow linear, involute, frequently somewhat twisted, both surfaces covered with adpressed, woolly hairs when young, the lower surface becoming glabrous with age. *Capitula* massed in rounded heads. Inner *involucral scales* pure white in colour in the upper part, narrow acute. *Pappus* of about 20 well developed bristles. *Corolla* a deep pink, with narrow, erect lobes, rather less than one third of the length of the tube. *Style* swollen at the base, seated on a waxy disc. *Ovary* covered with a dense felt of hairs.

Flowering season: November to December.

NAMAQUALAND. Middlekraal, Pillans 5606! CALVINIA: Uien Valley, Bokkeveld Mountain, Drege! CLANWILLIAM: Nardouw Mountains, Pearson 5423! Between Pikenier's Kloof and Markuskraal, Drege! MALMESBURY: near Kalabas Kraal, Salter 5100!

WITHOUT LOCALITY: Wallich! Niven!

Note.—Two specimens collected by Wallich have been examined. The one housed at Kew, the type of *S. squarrosa* Harv., differs from the one in the British Museum, named *S. leucocephala*, only in its more lax habit and its longer and more spreading leaves. The difference between the two specimens suggests that the one now at Kew originally grew under conditions of greater shade than the one in the British Museum. The species of this genus are prone to great variation in the leaves, and there seems to be no good reason for retaining *S. squarrosa* Harv.

34. STOEBE MICROPHYLLA DC. Prod. VI, p. 259 (1837) Harv. Fl. Cap. III, p. 280 (1865).

An erect shrub up to about 15 cm. high, with very slender, whip-like branches. *Leaves* minute, tightly adpressed, keeled, acute, glabrous below. *Capitula* in terminal, rounded heads, 1 cm. or a little more in diam. Inner *involucral bracts* white in the upper part, sharply acute. *Pappus* of about 16 bristles, longer than the corolla tube. *Corolla* with rather narrow, erect lobes about one quarter the length of the tube, deep pink in colour. *Style* swollen at the base, seated on a waxy disc. *Ovary* glabrous.

Flowering season. September—March.

MOSSEL BAY: Cloete's Pass, Muir 1455! UNIONDALE: Langkloof, Drege! Avontuur, Fourcade 2077!

DIVISION UNCERTAIN: Klipdrift in the Great Karroo, Schlechter.

REFERENCES.

1. COHEN, C. Stoebe sp. Journ. S.Afr. Bot. I, pp. 171-175 (1935).

2. LEVYNS, MARGARET R. Veld-burning Experiments at Ida's Valley, Stellenbosch. Trans. Roy. Soc. S.Afr. X. p. 61 (1929).

3. ——————————A Revision of Elytropappus Cass. Jour. S.Afr. Bot. I. pp. 89-103 (1935).

4. ——————————Germination in some South African Seeds. Jour. S.Afr. Bot. I. pp. 161-170 (1935).

5. ——————————A Revision of Disparago Gaertn. Jour. S.Afr. Bot. II. pp. 95-103 (1936).

NEW ALOES FROM NATAL AND ZULULAND, WITH NOTES ON A. MACRACANTHA BAK.

(With Plates I—V.)

By G. W. Reynolds.

Before describing new *Aloes*, it is necessary to discuss the identity of *Aloe macracantha* Bak. This is a puzzling species, the identity and locality of which seem to be unknown in South Africa to-day.

In the first publication,[1] Baker founded the species only on leaf characters and a stem of 2—3 feet, "*flores ignoti*"; there are no figures, the locality given being, "C.B. Spei, Cooper, introduced about 1870."

In the second publication,[2] we learn that *A. macracantha* is "native of the Cape Colony," and that it was "discovered by Mr. Thomas Cooper of Reigate in his travels through the eastern provinces of the Cape Colony from 1858 to 1862." The species is described *inter alia* with peduncle simple or forked about a foot long, inflorescence a dense corymb about 4 ins. in diameter, pedicels an inch or an inch and a half long (25—38 mm.), perianth nearly two inches long (say about 45 mm. long), segments half as long as the tube, which means segments free for one third their length. A leaf, raceme, and flowering plant are figured. The leaf has nothing distinctive about it, and could fit many species in the section *Saponariae*: the raceme is capitate, rather round topped, about as broad as long, while in it a flower measures 44 mm., a pedicel 30 mm. Regarding the plant figured, the stem and rosette are more suggestive of a young *A. arborescens* Mill. than anything in the section *Saponariae*, while the inflorescence bears only two racemes. No doubt the long slender stem and attenuate decurved leaves are the result of growing the plant overseas in a greenhouse, under protected conditions very different from the blazing sun of its natural South African habitat.

In the third publication[3] Baker adds little, but he distinctly gives "tube shorter than the segments" which means that the segments would be free to beyond the middle. He records "S. Africa without locality, introduced by Cooper about 1860." It seems that the date 1870 in the first publication is a mistake, since most of Cooper's introductions were effected about 1860.

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[1] *Vide* Journ. Linn. Soc. XVIII 1870, p. 167.
[2] *Vide* Curtis Bot. Mag. vol. XXXVII of the 3rd series, 1881, t. 6580.
[3] *Vide* Flora Capensis VI 1896, p. 314.

Berger, in the fourth publication[4] gives the stem as shortly caulescent, and pedicels 35—50 mm. In addition to "S. Africa locality unknown, Cooper 1860," evidently taken over from Baker, he gives "Bei Ripplemead, Kabousie in Kaffraria (Schonland-Bluhend April—July; Kult. Exemplare!)" The writer has consulted this material in Albany Museum Herb., and from the grouping of the 50 mm. long pedicels, the 45 mm. flowers, and the shape of the raceme, he is convinced that it should be referred to *A. saponaria*, which in its various forms, occurs from the Cape more or less along the Coastal belt through the Eastern Province and Transkei into Natal. By describing the stem as "*breviter caulescens*" and by giving the pedicel length as reaching 50 mm., it seems that Berger was influenced by Schonland's material of *A. saponaria* and confused it with *A. macracantha*, while in his account he has taken over some characters from Baker, and also included some from the Ripplemead plant. It therefore appears we must discard Berger's account, and rely on Baker for the identifying characters of the species. What then is *A. macracantha*, and where could Cooper have collected it? From Baker's accounts the species is characterised chiefly by a low sparingly branched inflorescence, capitate racemes with pedicels up to 38 mm., flowers about 45 mm., with the outer segments free to about the middle. As regards the possible locality, does Baker's reference to "the eastern provinces of Cape Colony" include Natal? There is ample evidence that Cooper collected in Natal and Zululand since Baker described *A. Cooperi* from grassy plains of Natal, and *A. sigmoidea* (without flowers) from "Amatonga country," which, if the same as is known as Amatongaland to-day, is the country east of the Lebombo mountains in north-eastern Zululand. It therefore seems that *A. macracantha* could have originated anywhere from the Eastern Province to Zululand.

If it came from the Eastern Province, Transkei, or the southern parts of Natal, it is most likely a form of *A. saponaria* with racemes slightly round topped and pedicels a little shorter than the 45 mm. flowers. This does not seem an impossibility, when the fig. of a raceme in *Bot. Mag.* is studied, and when allowance is made for cultivation overseas. It must be remembered that *A. saponaria* is a variable species characterised by racemes corymbose, pedicels 40—60 mm. and flowers 40—50 mm. long. Sometimes the pedicels are shorter than the flowers, but usually they exceed the length of the perianth.

If *A. macracantha* came from the north-eastern part of Natal, or from Zululand, then there are 3 other capitate species to be considered.

[4] Engler, *Das Pflanzenreich*, Liliac-Asphod-Aloin, 1908, p. 199.

(*a*) The only locality known to the writer where maculates are found in Natal and Zululand with stems reaching 2—3 feet (erect or decumbent), is in the neighbourhood of Muden, in the valley of the Mooi River near Keats Drift, and between Mpofana and Tugela Ferry. This species (which is hereinafter described as *A. mudenensis*) has been thought to be *A. macracantha*, but in the writer's opinion, it differs in too many respects. The racemes are longer than broad, the pedicels rarely exceed a length of 25 mm. with the perianth usually about 35 mm. long, while the segments are free for only 9—10 mm., and certainly not to the middle.

(*b*) A species now described *sub nomine A. umfoloziensis*, found principally in the valleys of the Black and White Umfolozi Rivers in Zululand. This species has pedicels mostly only 12—15 mm. long, with flowers usually about 33—35 mm. in length, and also differs in too many characteristics to be regarded as belonging to Baker's species.

(*c*) A species found further inland near Waschbank, Dundee, Vryheid, and what seems to be the same thing, in Swaziland near Mbabane. These plants, which at the Waschbank locality grow socially and cross with *A. saponaria*, do not fit the description and figs. of *A. macracantha* and appear to be distinct, but need further investigation.

During the last 4 years, the writer has made repeated journeys through the Eastern Province, Transkei, Natal, Zululand, Swaziland, etc., with a view to locating plants of *A. macracantha*, but without success. He has examined a considerable number of flowering plants, but could not regard any as fitting the description and figures within reasonable limits. It seems that *A. macracantha* is more likely to be a segregate of *A. saponaria* differing from the usual with racemes more round topped and pedicels shorter than the flowers, and that it is not typical of any species found in reasonable numbers. The writer, therefore, has reached the conclusion that *A. macracantha* should be dropped as being a species unknown in South Africa to-day.

Aloe mudenensis, Reynolds. Species nova in Sectione *Saponariarum*. *Planta* succulenta, caulibus usque ad 80cm. longis. *Folia* circiter 20, dense rosulata, lanceolato-attenuata, patentia, usque ad 25—30 cm. longa, 8—9 cm. lata, supra planiuscula caeruleo-viridia, maculata et lineata, subtus convexa, lineata, obscure maculata vel immaculata, ad margines sinuato-dentata, dentibus 5—7 mm. longis, 10—20 mm. distantibus, rectis vel deflexis. *Inflorescentia* 1—2, usque ad 1 met. alta ; scapus medio ramosus, rami 4—8 arcuato-erecti. *Racemi* subcapitati, cylindrici, leviter acuminati, circiter 12 cm. longi, 8—9 cm. lati. *Pedicelli* 20—25 mm. longi. *Bracteae* deltoideo-acuminatae, circiter

10 mm. longae, subscariosae, circiter 7 nervatae. *Perigonium* 35 mm. longum, basi subgloboso-inflatum et 9 mm. diam., supra ovarium constrictum (5 mm. diam.) hinc levissime decurvatum et faucem versus ampliatum. *Segmenta exteriora* per 9 mm. libera : interiora latiora obtusiora, marginibus pallidioribus. *Genitalia* usque ad 4 mm. exserta. Ovarium 8 mm. longum, 3 mm. diam.

Hab. Natal, near Muden, fl. 28th July, 1936, Reynolds 2029! (type) in National Herb. Pretoria and Bolus Herb. Kirstenbosch ; Tugela River Valley 3 miles north of Mpogana, fl. 28 July, 1936, Reynolds 2030! in Nat. Herb. Pretoria. Plants 1553—7—36 ex Muden and 1554—7—36 ex Tugela Valley in garden of Botanical Section, Div. of Plant Industry, Pretoria ; No. 1964/34 in National Botanic Gardens, Kirstenbosch. (Plate I).

This attractive species is found in considerable quantities near Muden, Natal, which seems to be its headquarters. It is also found along the Weenen Road, on the road towards Greytown, in the Mooi River Valley towards Keats Drift, South of Keats Drift towards Greytown, and in the Tugela Valley 2—4 miles North of Mpofana on the Greytown—Dundee main road. It prefers the lower areas of warm valleys, and was not found higher up on the mountain slopes. The species does not sucker freely nor form dense groups, but is usually found in small groups of 3—6 plants, although solitary plants with long stems are also met with. As regards development of stem, specimens occur with stems 2—3 feet long, either erect or decumbent ; when decumbent it seems that this is not a normal growth, but the result of plants having been blown over and re-rooted.

In leaf *A. mudenensis* varies considerably : usually the leaves are rather attenuate and of a peculiar bluish-green colour with a characteristic lineation of the lower surface, while in spotting the lower surface varies from lineate and immaculate to obscurely or distinctly spotted. The leaf sap dries reddish-purple.

The peduncle is usually 4—7 branched, while in strong forms as many as 15 racemes are sometimes produced. Racemes also vary in length and density, but in the form most typical of the species they are rounded at the apex, and almost twice as long as broad. The flowers are mostly salmon-orange (R.C.S.),[5] but forms are found ranging through orange to red.

From an examination of material taken from 24 different plants and the measurements tabulated, it was found that the lowest pedicels varied from 20 mm. to 25 mm. in length, the average being 23 mm., while in

[5] R.C.S. in all cases refers to colours taken from Ridgway's " Color Standards and Color Nomenclature," Washington, 1912.

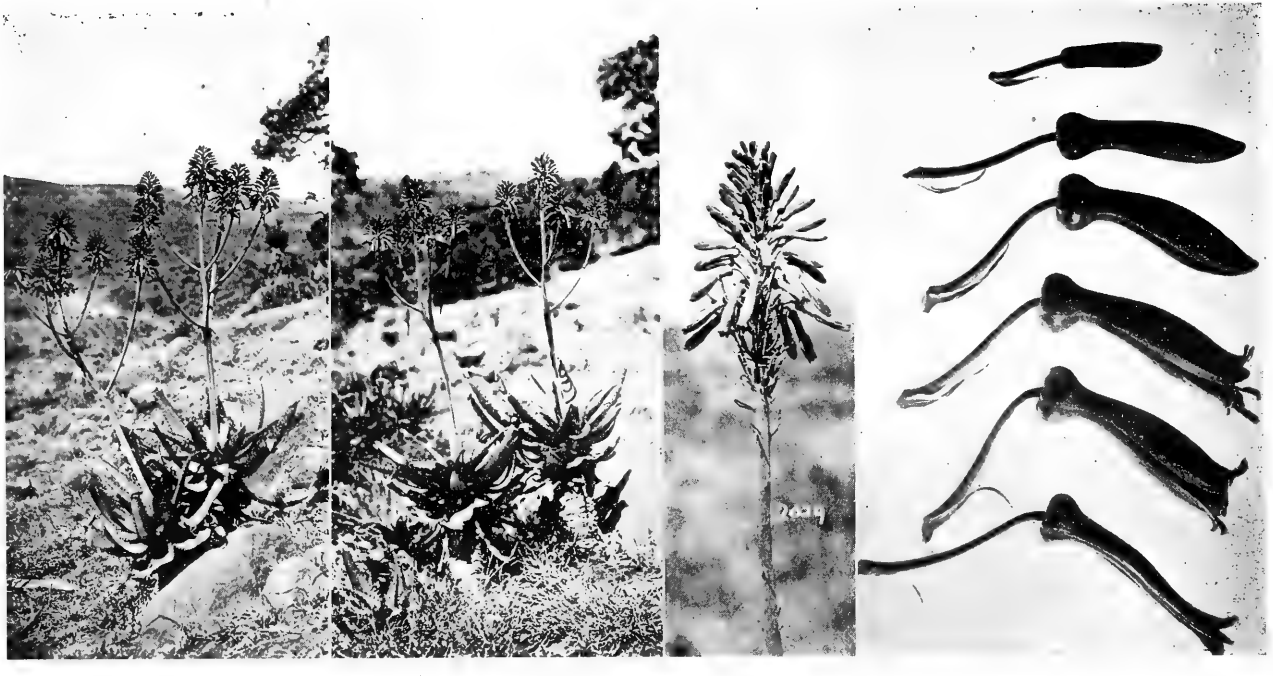

FIG. 1. FIG. 2. FIG. 3. FIG. 4.

Plate I: *Aloe mudenensis*, Reynolds.

Figs. 1 & 2. Plants in natural habitat, fl. 28 July, 1936, about 4 miles south-east of Muden, Natal.
FIG. 3. Raceme × ¼ approx.
FIG. 4. Flowers 1/1, from the bud to the post-pollination stage.

FIG. 1.

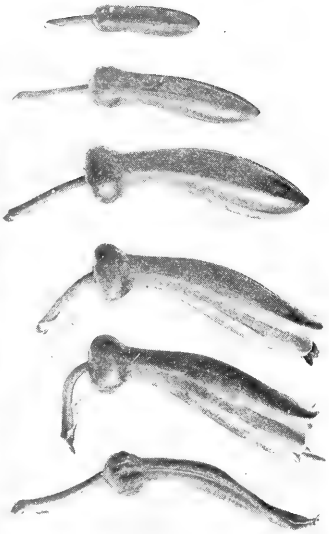

FIG. 2.

FIG. 3.

Plate II : *Aloe umfoloziensis*, Reynolds.

FIG. 1. Plants in natural habitat, Black Umfolozi Valley, 16 miles south of Nongoma, Zululand, fl. 24 July, 1936 (Reynolds 2011 ! type).

FIG. 2. Flowers 1/1, from the bud to the post-pollination stage.

FIG. 3. A more robust form, fl. 24 July, 1936, 4 miles south of Nongoma, Zululand.

the fruit the longest pedicel reached 30 mm. Bracts ranged from 12—15 mm. long, or slightly over half the pedicel length. The shortest perianth was 33 mm. long, the longest 40 mm., with 36 mm. the average ; the basal swelling averaged 8 mm. diam., the constriction above the ovary almost invariably 5 mm. diam. with the mouth of the flower wide open.

It has been thought that the Muden plants should be referred to *A. macracantha* Bak. (hereinbefore discussed), but they differ in too many respects to be considered conspecific with it, especially with regard to the shorter pedicels (23 mm. against 25—38 mm.) the shorter flowers (36 mm. against 38—45 mm.), the segments free for only 9 mm., the wide open mouth, and the slightly conical racemes longer than broad. These plants are therefore accorded specific rank, the description being based on personal observations in the localities stated, during July, 1933—36.

Description. Plants solitary or in small groups, with stems up to 80 cm. long, 10 cm. diam., erect or decumbent, old leaves not persistent. *Leaves* about 20, densely rosulate, lanceolate-attenuate, sub-erectly spreading, 25—30 cm. long, 8—9 cm. broad ; upper surface flat or slightly canaliculate, bluish-green with numerous irregularly scattered white oblong spots throughout, sometimes lineate ; lower surface convex, usually paler than the upper surface, lineate and immaculate or obscurely to distinctly spotted, the oblong dull white spots irregularly scattered or sometimes arranged more or less in undulating interrupted transverse bands ; the margins sinuate-dentate, horny, armed with teeth up to 7 mm. long, 10—20 mm. distant, the teeth deltoid pungent brown usually straight, sometimes slightly deflexed. The leaf sap dries reddish-purple. *Inflorescence* a branched panicle up to 1 met. high, sometimes 2 simultaneously. *Peduncle* up to 3 cm. diam. at base, brown, lightly covered with a grey powdery substance, branched about the middle with 4—8 arcuate-erect or sub-erect branches, the lowest branch subtended at base by an ovate-acute thin sub-scarious many nerved bract up to 25mm. long. *Racemes* sub-capitate, broadly cylindric slightly conical, the apex rounded, about 12 cm. long, 8—9 cm. broad, unicoloured salmon-orange (R.C.S.) the youngest buds erect, older buds horizontally disposed with the lowest open flowers cernuous. *Bracts* deltoid-acuminate, thin subscarious white about 7 nerved, usually slightly more than half the length of the pedicel. *Pedicels* 20—25 mm. long, up to 30 mm. in the fruit. *Perianth* salmon-orange, sometimes reddish, 35 mm. long with a sub-globose basal swelling 8 mm. diam., constricted to 5 mm. above the ovary, thence slightly decurved, enlarging towards the throat, the mouth wide open. *Outer segments* free for 9 mm., with paler orange margins and

sub-acute spreading apices. *Inner segments* dorsally adnate to the outer for three-quarters their length, broader than the outer and with more obtuse, more spreading apices, the pale marginal border twice as broad. *Filaments* pale lemon, flattened, the 3 inner narrower and lengthening in advance of the 3 outer. *Anthers* exserted up to 4 mm. *Style* yellower than the filaments, with the stigma at length exserted up to 5 mm. *Ovary* 8 mm. long, 3 mm. diam., finely 6 grooved, green.

Aloe umfoloziensis, Reynolds. Species nova in sectione *Saponariarum*. *Planta* succulenta, breviter caulescens, sobolifera, caespitosa. *Folia* circiter 20, dense rosulata, lanceolato-attenuata, patentia, 20—25 cm. longa, 8—9 cm. lata, supra planiuscula, maculata, subtus convexa, immaculata vel maculata; ad margines sinuato-dentata, dentibus 3—5 mm. longis, 10—15 mm. distantibus, rectis vel deflexis. *Inflorescentiae* 1—2, 1—1½ met. altae; scapus supra medium ramosus, ramis 5—8 arcuato-erectis. *Racemi* capitati, circiter 7—9 cm. longi et lati. *Bracteae* acuminatae, scariosae, plurinervatae, 8—12 mm. longae. *Pedicelli* 10—15 mm. longi. *Perigonium* 33—38 longum, basi globoso-inflatum (8—9 mm. diam.) supra ovarium constrictum (5—6 mm.), hinc leviter decurvatum et faucem versus ampliatum. *Segmenta exteriora* per 8—9 mm. libera, interiora latiora obtusiora. *Genitalia* usque ad 4 mm. exserta. *Ovarium* 8—9 mm. longum, 4 mm. diam.

Hab. Zululand: 4 miles south of Nongoma, fl. 24 July 1936, Reynolds 2008!; Black Umfolozi River valley, 16 miles south of Nongoma, fl. 24 July 1936, Reynolds 2011! (type); Pongola Valley 11 miles north of Magut, fl. 22 July, 1936, Reynolds 1993!: Transvaal: 1 mile north of Pongola, fl. 22 July, 1936, Reynolds 1992!, all in National Herbarium Pretoria. Plants 1486.7.36 ex Pongola, 1524.7.36 ex Black Umfolozi Valley, and 1483.7.36 ex near Otobotoni in garden of Botanical Section, Div. of Plant Industry, Pretoria. (Plate II.)

While describing the new species *A. umfoloziensis* it is advisable to discuss the peculiar conditions existing in Zululand. The botanist who has travelled during June—July from Natal through Zululand and Swaziland to Komatipoort in the far eastern Transvaal (over 350 miles), must have noticed the gradual transition which occurs in the winter flowering maculate *Aloes*. Broadly and briefly, in Natal *A. saponaria* is found with capitate corymbose racemes 10—15 cm. diam, pedicels and flowers 40—50 mm. long: in Zululand *A. umfoloziensis* is found with smaller round topped racemes 7—9 cm. long and broad, pedicels 12—15 mm., flowers 35—38 mm., while at Komatipoort only *A. pongolensis* occurs with longer cylindric-acuminate racemes 15—20 cm. long, pedicels 10—12 mm. and flowers 33 mm. long. There is a grading

from *A. saponaria* through intermediates to *A umfoloziensis*, and from *A umfoloziensis* through intermediates to *A. pongolensis*. In other words, there is a gradual transition from capitate 10—15 cm. diam. racemes in Natal, to cylindric-acuminate 15—20 cm. long racemes at Komatipoort; pedicels gradually decrease from 40—50 mm. long in Natal, to only 10—12 mm. at Komatipoort, and flowers from 40—50 mm. to 33 mm. Again, in Natal one frequently finds only *A. saponaria* growing, while at Komatipoort only *A. pongolensis* is found, but in the intervening valleys of Zululand there is the utmost confusion, due it seems, to the capitate *A. umfoloziensis* and the longer laxer *A. pongolensis* (and possibly another species) growing socially, crossing freely, and producing a bewildering variety in shape, size and colour of racemes.

The confusion is so tremendous, that the botanist must needs witness it himself and exercise great care before describing new species. If some of the plants which seemed distinct were to be described as new, there would be a spate of "new species" and it would be difficult to match the "type" unless a plant were obtained from one particular group. In these circumstances the writer feels it is inadvisable to "split" and that the more prudent course is, within reasonable limits, to "lump" the capitates under *A. umfoloziensis*, those with 10—20 cm. cylindric-acuminate racemes under *A. pongolensis*, and to regard intermediate shapes and sizes of racemes as being the result of hybridisation, or segregation from one or other species.

From an examination of much material gathered from various localities and the measurements tabulated, it was found that *A. umfoloziensis* was more or less fixed within the limits of racemes round topped 7—9 cm. long and broad, pedicels 10—15 mm. and flowers 35—38 mm. This combination of characters constitutes the principal distinguishing features of the species.

A. umfoloziensis is named after the locality which seems to be its headquarters, namely, ths valleys of the Black and the White Umfolozi Rivers in northern Zululand. It extends as far south as the Umhlatuzi valley (between Melmoth and Eshowe); it grows with *A. pongolensis* in countless thousands in the Pongola valley north of Magut and 50 miles east in the same valley near Otobotini, also much further north near Abercorn Drift in Amatongaland. Its habitat is principally low-lying sub-tropical parkland for some miles each side of rivers and watercourses, and varies greatly in different localities. Near Pongola some robust forms are found with leaves very decurved and giving the rosette a flattened appearance, this form has stouter peduncles and appears to differ sufficiently to warrant varietal rank, but is held over pending

further investigation. Sometimes solitary plants are found, but usually plants sucker freely and form dense groups often covering many acres. In one locality, such tremendous quantities were flowering as far as the eye could see, that the trees appeared to stand out of a lake of red. When growing in dense groups stems are short, leaves smaller and more spreading, with the inflorescence more slender (typical form); solitary plants or small groups found in exposed positions usually have longer stems, larger leaves and stouter peduncles. Since the species is found mostly in association with *A. pongolensis* (and possibly another species), and since so many intermediates and assumed hybrids occur, it follows that plants can be studied satisfactorily only when flowering wild in the veld.

An affinity to be considered is *A. deflexidens* Pillans,[6] recorded from "Zululand, exact locality not known." *A. deflexidens* is described *inter alia* with "*racemes* 7—15 cm. long, about 10 cm. wide, broadly conical dense, *pedicels* about 2 cm. long, pale red, *perianth* 4—4·3 cm. long, bright red." The long perianth and red pedicels seem to be unusual characters for Zululand plants, and during a recent trip through Zululand, the writer did not succeed in locating plants with this combination of characters.

Description.—Plant succulent, acaulescent or with stem up to 30 cm. long, freely suckering and forming dense groups. *Leaves* about 20, densely rosulate, lanceolate-attenuate, spreading or deflexed, up to 20—25 cm. long with a portion of the apex dried and twisted, 8—9 cm. broad at base; upper surface flat to slightly canaliculate, green to brownish-green, with numerous dull white oblong spots irregularly scattered or sometimes more or less arranged into a series of undulating interrupted transverse bands; lower surface convex, paler green, varying from immaculate to obscurely or distinctly spotted, usually somewhat lineate; the margins sinuate-dentate, armed with pungent deltoid brown teeth 3—5 mm. long, 10—15 mm. distant, straight or deflexed, the horny interspaces rounded. *Inflorescence* a branched panicle 1—1½ met. high, sometimes 2 simultaneously; peduncle flattened low down, 2—3 cm. diam. brown, lightly covered with a greyish powdery substance, branched about the middle or higher with 5—8 arcuate-erect branches, the lowest sometimes with a branchlet and subtended at base by an ovate-acute subscarious many nerved whitish bract up to 30 mm. long, 20 mm. broad at base. *Racemes* subdensely capitate 7—9 cm. long and broad, the apex rounded, unicoloured coral-red, the buds sub-erect, the open flowers cernuous to sub-pendulous. *Bracts* deltoid-acuminate, thin, scarious, white, about 5—7 nerved, shorter than the pedicels. *Pedicels*

[6] *Vide* S.A. Gardening, Feb. 1935, p. 36.

10—15 mm. long, reaching 20 mm. in the fruit. *Perianth* usually coral-red, 33—38 mm. long, with subglobose basal swelling 8—9 mm. diam., constricted above the ovary to 5—6 mm., thence slightly decurved and enlarging towards the throat, compressed laterally, the mouth usually wide open. *Outer segments* free for 8—9 mm., nerves not visible, paler at the margins, the apices sub-acute, spreading. *Inner segments* dorsally adnate to the outer for about $\frac{3}{4}$ their length, broader than the outer, with broader marginal pale border and more obtuse more spreading apices. *Filaments* flattened, the 3 inner narrower and lengthening in advance of the 3 outer, pale lemon in colour. *Anthers* the 3 inner and 3 outer in turn exserted 3—5 mm. *Style* slightly yellower than the filaments with the stigma at length exserted 3—5 mm. *Ovary* 8—9½mm. long, 4 mm. diam., finely 6 grooved, green.

Note.—The leaf sap dries purplish.

Aloe pongolensis, Reynolds, (*Fl. Plants of S. Africa*, Vol. XVI, Part 61, Jan. 1936, Plate 603) was described from plants flowering during June—August, 1935, in Johannesburg, and which were originally collected by the author at various localities between the Pongola and Great Usutu Rivers in low lying sub-tropical parkland west of the Lebombo range. During July, 1936, the author had opportunities of making further investigations in the far eastern Transvaal, Swaziland, east of the Lebombo range, and through most of Zululand, and in the light of further knowledge it can now be recorded that *A. pongolensis* has a much wider distribution than was at first thought, and that it is a species as variable as any in the section *Saponariae*. The form most typical of the species is characterised by a short stem, leaves very decurved and giving the rosette a very "flattened out" appearance, with racemes cylindric-acuminate 10—20 cm. long. (Komatipoort, fl. 4 July, 1936, Reynolds 1919!; Pongola, fl. 22 July, 1936, Reynolds 1991!, both in Nat. Herb. Pretoria.) The perianth of the type (Reynolds 1101 in Nat. Herb.) is described and figured with the mouth very wide open, and although such flowers are found at Pongola, the form which seems to be the most frequent is that now figured herein, Plate III, fig. 4.

At Komatipoort, the only winter flowering maculate *Aloe* found is *A. pongolensis*, but as the species extends southwards, it meets and crosses freely with the capitate *A. umfoloziensis*, and possibly another species, producing the tremendous confusion already referred to. Reference has also been made to the capitate species with long pedicels and flowers in Natal grading into the Zululand *A. umfoloziensis* with shorter flowers and pedicels, and it can be stated that a similar gradual

transition occurs with *A. pongolensis*. At Komatipoort *A. pongolensis* has racemes up to 20 cm. long, with pedicels mostly 10—12 mm. long and flowers averaging 33 mm. in length. Southwards through Swaziland into Zululand there is a gradual change to longer racemes pedicels and flowers, until in the White Umfolozi valley (12 miles south of Mahlabatini) plants are found which differ sufficiently to warrant at least the varietal rank now proposed.

Aloe pongolensis, Reynolds, var. **zuluensis,** Reynolds. Varietas nova, a forma typico caulibus longioribus, foliis minus decurvatis, racemis pedicellis et floribus longioribusque differt.

Hab.—Zululand : White Umfolozi valley, fl. 24 July, 1936, Reynolds 2017! (type) ; Black Umfolozi valley, 16 miles south of Nongoma, fl. 24 July, 1936, Reynolds 2012! ; 7 miles south of Nongoma, fl. 24 July, 1936, Reynolds 2010! all in Nat. Herb. Pretoria. Plants 1525.7.36 (ex Black Umfolozi valley) and 1528.7.36 (ex White Umfolozi valley) in garden of Botanical section, Div. of Plant Industry, Pretoria. (Plate IV.)

The var. *zuluensis* differs from typical *A. pongolensis* with stems reaching 30—40 cm. long ; solitary plants and small groups occur, dense groups from suckers were not noticed. The leaves are more obliquely spreading and not so decurved, while the rosettes have not the " flattened out " appearance so typical of *A. pongolensis*. The racemes are longer (25—30 cm.) with pedicels 12—15 mm. long, and flowers averaging 37—40 mm. in length. The variety is often found growing socially with *A. umfoloziensis* and crosses and intermediates are frequent ; it therefore follows that plants should be collected only while flowering, when specimens typical of the variety can be selected. For purposes of comparison, photographs of flowering plants taken at Komatipoort, Pongola, and the White Umfolozi valley are reproduced herein.

Description.—Plants solitary or in small groups, with stems 30—40 cm. long. *Leaves* about 16—20, densely rosulate, lanceolate-attenuate, spreading, up to 30 cm. long, 8—9 cm. broad at base, with a portion of the apex dried and twisted ; upper surface flat to slightly concave, brownish-green with numerous oblong whitish spots irregularly scattered or arranged more or less into a series of undulating transverse bands ; lower surface convex, sometimes immaculate, usually with obscure to distinct spots arranged in transverse bands, and usually paler than the upper surface ; margins sinuate-dentate, armed with deltoid brown pungent teeth 5—6 mm. long, 10—15 mm. distant, straight or deflexed, the interspaces rounded. *Inflorescence* 1—2, up to 1—1·5 met. high, branched about the middle or higher with 5—8 branches, the lowest

FIG. 1.

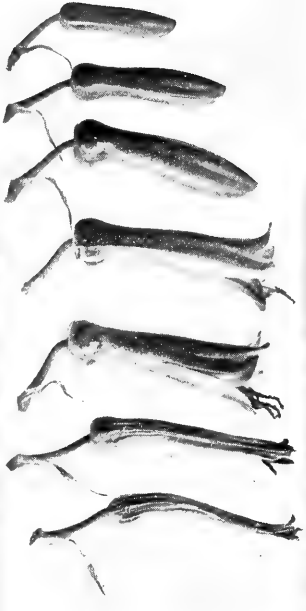

FIG. 2.

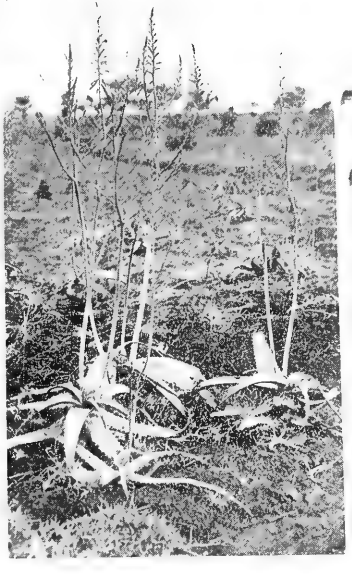

FIG. 3.

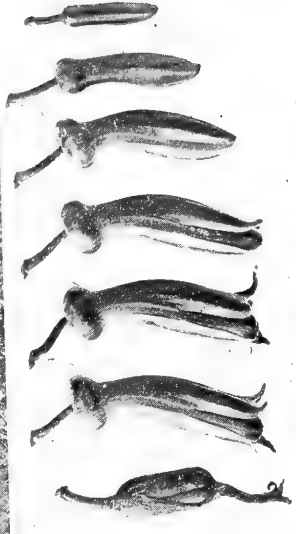

FIG. 4

Plate III : *Aloe pongolensis*, Reynolds.

FIG. 1. Plants fl. 21 July, 1936, in the Pongola Valley, S.-East Transvaal (type locality), about 12 miles north of Magut, Zululand.
FIG. 2. Flowers 1/1, from a plant at Pongola, S.-East Transvaal.
FIG. 3. Plants fl. 4 July, 1936, at Komatipoort, Eastern Transvaal.
FIG. 4. Flowers 1/1, from a plant at Komatipoort.

Fig. 1. Fig. 2.

Plate IV: *Aloe pomplensis*, Reynolds, var. *zuluensis*, Reynolds.

Fig. 1. Plants fl. 24 July, 1936, in the valley of the White Umfolozi River, 12 miles south of Mahlabatini, Zululand.

Fig. 2. Plants fl. 24 July, 1936, 7 miles south of Nongoma, Zululand.

sometimes with a branchlet and subtended at base by attenuate subscarious thin white many nerved bracts up to 3—4 cm. long. *Racemes* cylindric and slightly acuminate, the terminal 25—30 cm. long, 8 cm. broad, about 50 flowered, the buds sub-erect, not densely congested, the open flowers 10—15 mm. distant. *Bracts* thin scarious white many nerved, as long as the pedicels or slightly shorter. *Pedicels* 12—15 mm. long. *Perianth* coral-red, 37—40 mm. long, subglobosely inflated at base (10 mm. diam.), constricted above the ovary to 6 mm., thence slightly decurved and enlarging towards the throat, and with wide open triangular mouth. *Outer segments* free for 10 mm. the margins paler, the apices sub-acute, spreading. *Inner segments* dorsally adnate to the outer for about 30 mm., broader than the outer and with broader pale marginal border, the apices more obtuse more spreading. *Filaments* flattened, the 3 inner narrower and lengthening in advance of the 3 outer. *Anthers* exserted 2—3 mm. *Stigma* at length exerted 2—3 mm. *Ovary* 9—10 mm. long, 3—3·5 mm. diam. finely 6 grooved green.

Note.—The leaf sap dries purplish.

Aloe Keithii, Reynolds. Species nova in sectione *Saponariarum*, *A. zebrinae* Bak et *A. pongolensi* Reynolds affinis. Planta succulenta, caulibus usque ad 30 cm. longis. *Folia* circiter 20, dense rosulata, lanceolato-attenuata patentia, usque ad 60—70 cm. longa, 9—11 cm. lata ; supra subcanaliculata, viridia, maculis oblongis albidis numerosis transverse irregulariter fasciatim picta ; subtus convexa, immaculata vel interdum obscure maculata ; ad margines sinuato-dentata, dentibus corneis pungentibus brunneis leviter deflexis 6—8 mm. longis, 10—20 mm. inter se distantibus armata. *Inflorescentia* usque ad 1·75 met. alta ; scapus medio 5—8 ramosus. *Racemi* cylindrico-acuminati, 20—25 cm. longi, 7—9 cm. lati. *Bracteae* deltoideo-acuminatae, subscariosae 5—7 nervatae, 15—20 mm. longae. *Pedicelli* circiter 15 mm. longi. *Perigonium* rubrum, 36 mm. longum, basi valde inflatum et 11—12 mm. diam., supra ovarium constrictum (6 mm.) hinc leviter decurvatum et faucem versus ampliatum. *Segmenta exteriora* per 12 mm. libera, subacuta, marginibus pallidioribus ; interiora latiora obtusiora. *Genitalia* 2—4 mm. exserta. *Ovarium* 10 mm. longum, $3\frac{1}{2}$ mm. diam.

Hab. Eastern Swaziland : along the top of the Lebombo range, 26 miles south of Stegi, fl. 21 July, 1936, Reynolds 1983! (type) in National Herb. Pretoria. Plants 1467.7.36 in garden of Botanical Section, Div. of Plant Industry, Pretoria, and 1714.36 in National Botanic Gardens, Kirstenbosch. (Plate V.)

This new *Aloe* was first brought to the Author's notice by Capt. D. R. Keith who has many specimens in cultivation in his garden 6 miles south of Stegi. Capt. Keith records that he has not found this species on the Portuguese side of the hills, and that it appears to be confined to deep rich soil on the western part of the Lebombo range, between Stegi and Usutu Poort (Abercorn Drift). During July, 1936, the Author had an opportunity of visiting the Lebombo range, and he found the species growing 17 miles and 26 miles south of Stegi, while further south, some robust plants were found at a point about 7 miles north of the Great Usutu river. The description is drawn up from personal observations at these localities.

In shape and size of flowers, *A. Keithii* seems near *A. zebrina* Bak.[7] but differs from the S.W. African plants with much longer leaves, purplish sap, denser shorter racemes and the flowering period. The very large basal swelling of the perianth (11—12 mm.) suggests an affinity with *A. barbertoniae* Pole Evans[8] but *A. barbertoniae* has comparatively narrower flowers and laxer longer racemes.

It has been suggested, that due to its growing along the top of the mountain in the mist belt, *A. Keithii* is merely a robust form of *A pongolensis* which occurs in the drier valleys below in such tremendous quantities, but there are too many points of difference for them to be conspecific.

A. Keithii is found solitary or in small groups, with a stem reaching 30 cm. in length, with the leaves suberectly spreading, while *A. pongolensis* has little or no stem, suckers freely and forms dense groups while the leaves are decurved giving the rosettes a low "flattened out" appearance. The flowers of *A. Keithii* are also very different from those of *A. pongolensis* being larger and broader, and with a considerably larger basal swelling as is well illustrated in the accompanying figures.

In some respects *A. Keithii* resembles *A. pongolensis* var. *zuluensis*, but the latter is a smaller plant with smaller leaves and narrower flowers.

Description. Plants with stems up to 30 cm. long, solitary or in small groups. *Leaves* about 20, densely rosulate, lanceolate-attenuate, erectly spreading, up to 60 cm. long, 9—11 cm. broad at base; upper surface slightly canaliculate, green, slightly brownish towards apex, somewhat indistinctly lineate, with numerous distinct or obscure elongated whitish spots, the spots scattered or irregularly arranged in a series of interrupted undulating transverse bands; lower surface convex, paler green, mostly

[7] *Vide* Engler: Das Pflanzenreich, Liliac.-Asphod.-Aloin., p. 207.
[8] *Vide* Trans. Roy. Soc. S.Af., vol. V, part 6, plate LII.

FIG. 1.

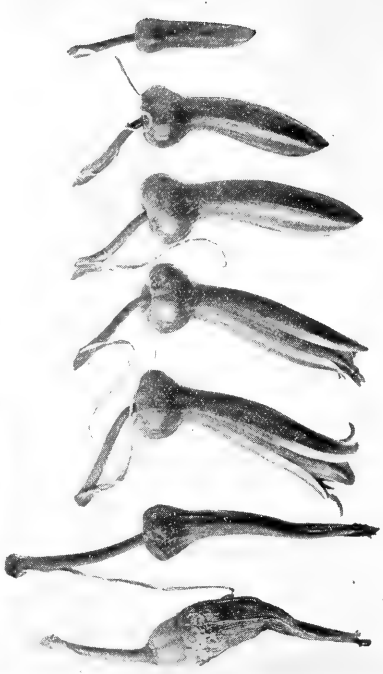

FIG. 2.

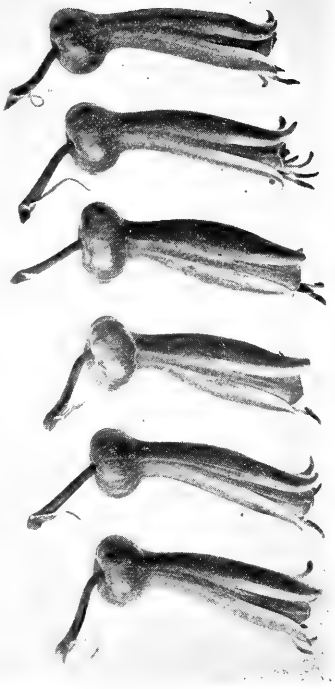

FIG. 3.

Plate V: *Aloë Keithii*, Reynolds.

FIG. 1. Plants fl. 21 July, 1936, along the top of the Lebombo range, 26 miles south of Stegi, Eastern Swaziland.
FIG. 2. Flowers 1/1, with bracts longer than usual, taken from a plant illustrated in fig. 1.
FIG. 3. Flowers 1/1 taken from different plants, illustrating variation in shape and size.

immaculate, sometimes with obscure immersed spots more or less in irregular bands ; margins sinuate-dentate, armed with deltoid pungent brownish teeth 6—8 mm. long, 15—25 mm. distant, straight or a little deflexed, the interspaces rounded. *Inflorescence* 1—2, up to 1·75 met. high ; the peduncle flattened low down and up to 4 cm. diam., lightly covered with a greyish powdery substance, branched about the middle or higher with 5—8 branches, the 1—2 lowest sometimes with 1—2 branchlets. *Racemes* cylindric-acuminate, about 20—25 cm. long, 7—9 cm. broad, with the buds slightly congested, greenish tipped and not striped, gradually slightly laxer downwards with the open flowers 15—25 mm. distant. *Bracts* deltoid-acuminate, thin, rather scarious, about 5—7 nerved about as long as the pedicels or slightly longer. *Pedicels* 12—15 mm. long, reaching 20 mm. long in the fruit. *Perianth* coral-red, 36 mm. long, with a conspicuous basal swelling 11—12 mm. diam., severely constricted above the ovary to 6 mm. diam., thence slightly decurved and enlarging towards the throat, the mouth usually wide open. *Outer segments* free for 12 mm., with paler edges and subacute spreading apices. *Inner segments* dorsally adnate to the outer for about 20 mm., broader than the outer, and with the pale marginal border twice as broad, the apices more obtuse and more spreading. *Filaments* flattened, the 3 inner narrower and lengthening in advance of the 3 outer. *Anthers* the inner and outer in turn exserted 2—4 mm. *Stigma* at length exserted 2—4 mm. *Ovary* 10 mm. long, $3\frac{1}{2}$ mm. diam. at base, slightly tapering into the style, finely 6 grooved, green.

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VOL. II.

AN ECOLOGICAL STUDY OF A PIECE OF KARROO-LIKE VEGETATION NEAR BLOEMFONTEIN.

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AND

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SECTION I.

Introduction.

Bloemfontein lies within the vegetation region characterised by vast, undulating, bunch-grass plains, termed by Bews (1918) the Eastern Grassveld, in which the " rooigras " (*Themeda triandra*) is dominant. It is of interest then to find in this region a small area (approximately 18 square miles) showing marked affinities with the Karroo. Bews (1925) makes mention of similar areas on the very dry valley-slopes of the Tugela, and Lower Mooi rivers in Natal, but as far as can be ascertained the area under discussion is the most northerly outlier of the Karroid type of vegetation.

The terms " bult " and " koppie " are used in this paper in definite contra-distinction. By " bult " is meant a large, mound-like elevation rounded off by gently inclined sides ; the " koppie " is usually higher, with steep sides, and rises sharply from the surrounding levels. The term " bush " is used to denote close or semi-close stands of trees, and by " scrub " is meant vegetation characterised by scattered, stunted trees and shrubs.

Of the nine associations (plant communities) described, five have been named after the dominant species which characterise them, and four after the situations which they inhabit.

For the benefit of those who are not familiar with the botanical names of the plants, the common names of these, where known, will be found together with the botanical names in Section III.

Most of the ecological work in this report was done between December, 1933, and July, 1935.

Acknowledgements.

Thanks are due to (1) the Soil Erosion and Pasture Research Grant Board for a grant which has rendered the work possible; (2) several landowners for kindly permitting the freedom of their farms. Of these we are also particularly grateful to Mr. Justice P. U. Fischer, Mr. C. J. Goodrick, Dr. O. F. A. Krause and Adv. C. A. Beck for useful information and stimulating suggestions; (3) Mr. E. J. M. Besaans for making two outline copies of the original field-map, and for lettering them; (4) the Department of Meteorology for tables 1 and 2; (5) Mr. I. B. Leviseur for the use of surveyors' chains and tape; (6) the National Herbarium, Pretoria, and the Bolus Herbarium, Cape Town, for naming certain plants.

General Description of Site.

The region investigated (referred to as the Area) is approximately 18 square miles in extent, and is situated immediately to the north of the townlands of Bloemfontein. It is bounded practically on all sides, as seen in Map 1, by grassveld, and has the general appearance of an island of short, open scrub raised in a sea of gently undulating grass, the continuity of which is broken by the protrusion, at varying intervals, of flat-topped koppies.

The Area is built of koppies and bults separated by winding valleys and gullies (Plate 6A) through which wander dry spruits and sloots. The soil is, on the whole, extremely shallow, and on all sides exposed rock outcrops meet the eye. The site is clothed mainly by short open scrub, in which are scattered small areas of bush and grassland. The level of the Area fluctuates between 4,400 and 4,800 feet altitude. The Area presents an isolated type of vegetation and possesses a number of distinct plant communities.

Methods.

A reconnaissance of the Area was made, and its boundaries and plant communities noted.

A map of the Area was made showing the distribution of the various associations. The map is based on the Ordnance Survey, enlarged approximately seven times, linear measurement,

Line and belt transects were made through portions of the various plant communities.

Observational records were employed in tracing the early succession.

Photographs were taken to illustrate observations and charts.

Instrumental records were made of various factors operating in the Area. (These records are indicative, rather than absolute, as the cost of the instruments necessary for complete records placed them out of reach.)

Mechanical and chemical analyses of the various soils in the Area could not be undertaken, nor has it been possible to make a study of root habits.

Instruments Used.

1. For line transects,—surveyor's steel tape, 300 Cape feet in length.
2. For belt transects,—pair of surveyor's chains (60 Cape feet), with lengths of thin cord stretched between them at suitable intervals.
3. For quadrats,—lengths of galvanised strap-iron, arranged in squares of 1 m. side (*v.* Weaver and Clements, 1929).
4. Photography,—Voigtländer " Brilliant " camera, F/4 ·5, and Voigtländer quarter-plate camera, F/6 ·3.
5. Temperature readings,—ordinary centigrade thermometers.
6. Humidity readings,—wet-and-dry bulb whirling hygrometer.
7. Wind velocities,—Birma's Fan-Anemometer.
8. Light intensities,—Imperial Exposure Meter.
9. For measurement of evaporation,—evaporimeters constructed on the plan of Pickering's Standard instrument. The reservoirs were graduated in ccs., and to prevent heating of the water they were placed in polished metal containers (cocoa tins) and packed with sawdust.
10. For determining the angle of slope,—Gallenkamp's combined Theodolite-Sextant-Clinometer.
11. For determining soil reaction,—B. D. H. Soil Testing Outfit.
12. For water-content determinations,—electric drying oven.

SECTION II.

(*a*) Climate.

The climate is one of summer rains, and, like that of the greater portion of the Orange Free State, it is of a very rigorous nature. Cold, dry winters are succeeded by long, hot summers with a low rainfall. Long periods of heat and drought are generally followed by heavy showers of rain—from 1 to $1\frac{1}{2}$ inches may fall in the course of an hour—which cause considerable erosion as shown in Plate 9A. Hail is of frequent occurrence, causing much damage to orchards, crops and gardens, but snow is very rare, four light falls having been recorded during the past 22 years.

The average annual precipitation during the period 1916-1933 was 20·19 inches; during the period 1928-1933 it was only 16·89 inches, and, as seen in Table 1 the number of rainy days in each year is very small. From the table it will be seen that spring rains are scanty. In response to the rise in temperature in spring, the grasses may commence growth, and become green, but they are very soon withered and browned by heat and drought, and remain so until the first rains of summer. In this season, too, prolonged periods of drought are of yearly occurrence, and it is very seldom that the herbaceous vegetation remains green throughout a summer.

Great extremes of temperature are experienced in the Bloemfontein district (*v.* Table 2); temperatures above 70° F. may be reached during the day in mid-winter, and at night they may fall below 15° F. In summer, insolation is intense; air temperatures of 90° F. are frequent, while soil temperatures, at a depth of 2 inches, may rise above 107° F. (42° C.). High temperatures in summer are usually accompanied by low atmospheric humidity—in 1933 the average daily humidity during the summer months was in the neighbourhood of 27%, while temperatures soared well above 90° F. (*v.* Table 2)—causing thus excessive evaporation. The ratio, evaporation/rainfall of the same year was 84/14 (inches); the normal ratio, however, is about 70/20.

Winter is a dangerous period for plants; often in mid-winter, warm days are succeeded by intense cold at night, and short periods of warm, sunny days, and frost-free nights may be followed by periods of low temperature and severe frost. A succession of frosty nights frequently occurs in spring, after deciduous plants have already donned their foliage —in 1935, frost was recorded as late in the season as November 17th.

During late winter, spring, and frequently during the summer months, the vegetation is subjected to hot, drying winds which sweep across from the arid west. During summer, more or less localised cyclonic winds are prevalent. These pass through all points of the compass in the

TABLE I

RAINFALL
(INCHES)

STATION : BLOEMFONTEIN.
LAT.: 29° 07′ S.
LONG.: 26° 12′ E.

Year.	Jan.		Feb.		Mar.		April.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.		Year.		Summer. (Oct.-Mar.) Inches.	Winter. (April-Sept.) Inches.
	In.	Dys.	In.	Dys.	In.	Dys.	In.	Dys.	In.	Dys.	In.	Dys.	In.	Dys.	In.	Dys.	In.	Dys.	In.	Dys.	In.	Dys.	In.	Dys.	In.	Dys.	Days.	Days.
1930	2·32	10	1·91	6	3·06	7	2·17	7	0·65	1	0·14	2	0·00	0	0·13	3	0·00	0	0·38	2	0·40	4	1·19	7	12·35	49	9·26 36	3·09 13
1931	6·34	14	2·52	11	2·70	11	4·15	11	0·00	0	0·02	1	1·80	4	0·14	1	0·00	0	1·59	5	3·25	8	0·52	4	23·03	70	16·92 53	6·11 17
1932	1·68	3	2·75	10	2·98	9	0·00	0	0·11	1	0·00	0	0·01	1	0·00	0	2·28	3	1·63	6	0·98	6	2·37	5	14·79	44	12·39 39	2·40 5
1933	0·58	6	1·36	5	1·47	6	1·07	4	0·16	1	0·09	2	0·00	0	0·19	2	0·00	0	0.24	1	5·46	14	4·64	8	15·26	49	13·75 40	1·51 9
1934	5·03	15	3·53	11	2·15	11	1·57	5	1·22	7	0·00	0	0·43	3	0·09	2	0·09	1	2·33	5	2·18	8	2·53	7	21·15	75	17·75 57	3·40 18
Means	3·19	9·6	2·41	8·6	2·47	8·8	1·79	5·4	0·43	2	0·05	1	0·45	1·6	0·11	1·6	0·47	0·8	1·23	3·8	2·45	8	2·25	6·2	17·32	57·4	14·01 45	3·30 12·4

TABLE II

TEMPERATURES (°F).

STATION : BLOEMFONTEIN.
LAT.: 29° 07′ S.
LONG.: 26° 12′ E.

Year.	January.		February.		March.		April.		May.		June.		July.		August.		September		October.		November.		December.	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1930 Mean	83·4	58.8	84·0	56·7	79·7	54·8	71·5	45·3	67·8	36·8	59·6	32·3	63·2	32·3	64·5	34·9	70·8	38·2	79·1	52·5	85·3	57·1	88·2	60·1
1930 Absolute	90·1	50·0	97·1	45·1	90·7	42·7	79·4	34·0	73·4	28·0	63·0	25·2	69·3	26·0	75·8	26·5	84·5	27·4	92·2	35·2	95·2	46·9	90·0	42·4
1931 Mean	84·4	61·0	84·4	60·7	80·6	57·8	68·4	47·4	70·3	40·3	61·4	32·1	57·0	32·8	67·6	36·2	72·1	42·1	78·1	49·4	79·5	56·3	88·0	56·5
1931 Absolute	92·2	51·2	90·5	56·7	88·0	49·6	83·1	34·8	77·2	28·4	67·5	17·6	69·0	24·1	79·1	24·2	84·8	25·9	94·8	37·1	91·6	50·4	94·3	51·0
1932 Mean	86·2	57·3	83·4	59·8	79·4	57·8	79·1	52·2	69·0	43·6	63·6	28·8	61·3	29·6	69·7	33·8	73·2	45·3	79·5	52·9	84·0	53·8	87·0	57·0
1932 Absolute	99·0	44·7	91·3	50·4	86·5	48·8	83·4	42·1	74·9	33·6	68·4	22·7	71·0	22·3	81·1	26·8	84·0	33·0	90·0	39·2	95·6	45·0	95·2	41·5
1933 Mean	88·6	61·5	88·9	61·1	84·4	56·6	75·1	47·2	70·5	37·3	58·1	27·0	62·4	31·2	67·8	36·2	74·9	45·0	82·2	49·2	77·4	55·7	81·0	59·4
1933 Absolute	96·0	56·6	94·6	53·8	90·8	48·3	84·8	36·7	80·8	23·2	69·5	14·4	71·5	19·0	74·7	26·3	86·6	34·0	93·0	36·6	84·9	44·0	93·0	52·0
1934 Mean	78·5	59·6	79·4	56·0	78·3	53·3	74·0	47·9	70·0	40·6	65·2	34·0	61·7	31·3	69·7	37·0	75·1	41·6	78·5	48·3	79·5	55·2	81·6	56·5
1934 Absolute	86·8	52·3	90·9	43·5	85·9	38·9	85·8	35·6	80·0	34·2	70·5	27·2	74·6	17·7	78·5	23·8	87·6	29·0	96·5	37·2	87·9	44·0	90·6	48·6
Means	88·5	55·3	88·5	54·4	84·4	79·3	78·5	42·3	73·4	35·7	63·7	26·1	66·4	26·6	72·8	47·6	79·4	36·1	86·4	43·4	86·1	50 9	89·2	52·5

course of a single day ; arising in the early morning in the east or south-east, they veer through north, to west, by noon, and by sunset they are sweeping across from the south, shortly after which they generally cease. Prolonged winds from the north and north-east are usually followed by precipitation, but these winds are infrequent.

Owing to the severe climate the vegetation is mostly xerophytic in character. Trees are somewhat poorly represented, occurring only in situations where, due to topography, the conditions of soil-depth and water-supply are more favourable, viz., on southern faces of koppies, south-facing sides of valleys, along spruits in the valley bottoms, and along the sides of rocky dongas among the koppies.

For other aspects of the climate of Bloemfontein *v.* Potts (1922, pp. 147-154.)

(*b*) Geology and Topography.

The Area consists of a doleritic boss which overlies rocks of the Beaufort Series. Owing to the weathering of the dolerite, the Area has become honeycombed by a network of valleys and dongas, traversed by dry spruits and sloots, leaving between them raised masses—the koppies and bults. The site is thus of a very irregular and broken nature (Plate 6A) with sharp transitions between the various levels and offers many and varied habitats. This is reflected in the number of different plant communities found, and in the richness of the flora.

(*c*) Soils.

The soils are all of doleritic origin. Their exceptional shallowness, on the whole, is an outstanding feature of the Area. The only situations which possess soils of any appreciable depth are (*a*) the valleys and depressions containing deep alluvial deposits, which, in the valleys, may reach a depth of over 40 feet ; and (*b*) the southern faces of koppies, and south-facing sides of valleys with steep talus slopes. (The actual depth of the talus is difficult to estimate.) For the rest, as already mentioned, the soils are exceptionally shallow ; on the bults, for example, they seldom exceed a depth of 9 inches.

A very large proportion of the soil, formed on the bults and koppies from the weathering of the rock, is washed down by heavy showers of rain into the valleys and depressions.

The soils of the koppies and bults are brown ; they are of a coarse, gravelly or sandy nature, and show a neutral reaction. Those of the depressions and valleys, on the other hand, are of the dark-coloured turf type, with a fairly high clay content (as seen from their plasticity when wet), and slightly acid reaction. The soils of the bush-covered talus

slopes are also dark in colour, but they show a neutral reaction ; their dark colour is due to humus.

(*d*) Effects of Man.

Relative to the density of the population, the effects of man are not very great ; the vegetation still persists, in places, in what seems to be an almost natural condition. The nature of the topography and of the soils does not permit of extensive cultivation ; small cultivated areas are restricted generally to depressions and valley bottoms, where the soil is deep and uniform. It is essentially a stock-farming area, and the disturbances caused by man, therefore, are chiefly due to his grazing animals, which, as will be seen in the following section, have assisted in causing certain changes to take place in the vegetation.

Here and there man has produced slight changes in the topography. By the damming of sloots in gullies considerable depths of soil have been built up by silting. The new scheme of Government assistance to farmers, for the conservation of soil and water, bids fair to bring about marked changes in the physiognomy of the lower-lying areas. Adv. C. A. Beck, for example, has recently taken advantage of this assistance, and has converted a series of dongas, spruits and sloots, on Bayswater (Map 1) into an extensive system of water conservation. Where earlier there was but a dry system of spruits and water-courses, there exists now a series of bodies of permanent water (not shown on the map) and this is bound to cause, in time, considerable change in the vegetation of the affected areas.

SECTION III.

The Vegetation.

(*a*) General Account.

Within the Area there are distinguished 3 major types of vegetation : scrub, bush and grassland. These are further subdivided into 9 associations : scrub 5, bush 3 and grassland 1. (Map 1.)

Scrub.

This is by far the most extensive of the three types. It occupies approximately 92% of the total vegetational cover of the site, extending over all the higher areas except the slopes of koppies, and sides of valleys which face south and south-east ; on these it is generally ousted by bush. On eastern faces, too, scrub is occasionally displaced by small patches of bush.

Scrub comprises the following 5 associations :—

(1) *Mesembryanthemum spinosum—Euphorbia mauritanica,*
(2) *Euryops sulcatus—Euphorbia mauritanica,*
(3) *Euryops sulcatus—Themeda triandra,*
(4) *Koppie scrub,* and
(5) *Rhus ciliata—Themeda triandra.*

Bush.

Bush is less extensively developed than scrub, occupying but 6% of the total vegetational cover. It is almost wholly confined to the slopes of koppies and sides of valleys which face south or south-east, to the sides of dongas, and to valley bottoms (*v.* Plate 8). As previously mentioned, however, small patches of bush occasionally extend to eastern faces of slopes, especially where these are steep.

Bush comprises 3 associations : koppie bush, spruitbank-valley bush, and Acacia bush.

Grassland.

Pure grassland is represented in the Area by one association, valley grassland. This is more luxuriant than and differs somewhat in composition from the grassveld surrounding the Area. It occurs only in depressions, in deep soil varying from 4 to over 20 feet in depth. It is found (*a*) following watercourses which wander down from the upper levels, (*b*) occupying small flushes (seasonal vleis) and (*c*) among bush clumps in the valleys. The association occupies the remaining 2% of the vegetational cover of the Area.

(*b*) The Associations.

(The Roman numerals I-VIII, including IVa, in Map 1 mark the points at which transects, Figs. I-VIII, were made.)

1. *Mesembryanthemum spinosum—Euphorbia mauritanica.*

(Plate 7A, and Fig. I.)

This association is a succulent scrub characterised by the two dominant plants, *M. spinosum* and *E. mauritanica*. Through it is sometimes scattered, too, the hard-leaved or sclerophyllous *Euryops sulcatus*. The association inhabits very rocky areas on the bults, where there is virtually no soil-cover except in small patches in shallow pockets and depressions in the rock. Large portions of the bults are so constituted; the roots of the shrubs penetrate and ramble among interstices of the rock.

Very characteristic of the association, but less conspicuous than the above plants on account of its smaller stature (6 in.—8 in.), is the dwarf-shrub *Eriocephalus spinescens*, while the suffrutescent *Sutera argentea* is also a common component. In rock crevices, among the dominant plants, are typically present tufts of several species of cleft-inhabiting, or chasmophytic grasses. Chief among these are *Eustachys paspaloides*, *Rhynchelytrum roseum* and *Aristida Burkei*. Occasionally inhabiting these crevices, too, are the ferns *Notholaena Eckloniana* and *Pellaea hastata*, as well as isolated tufts of the grasses *Digitaria eriantha* and *Themeda triandra*. Between the exposed sheets of rock are situated small patches of shallow ($\frac{1}{2}$ in.—$1\frac{1}{2}$ in.) soil, bound by colonies of short, xerophytic grasses, chief of which is *Eragrostis denudata* (*v.* Fig. I) which forms short (3 in.—$5\frac{1}{2}$ in.), closed communities in these situations. Other grasses are *Lepturella capensis*, *Microchloa caffra*, *Tragus koelerioides*, *Eragrostis obtusa* and *Eragrostis* sp. nr. *Atherstonei*. *Aristida barbicollis* and *A. congesta* are commonly represented, while the composite *Geigeria passerinoides*, and the sedge *Mariscus capensis* are characteristic, associated plants of such situations. Among these plants, in the shallow soil-patches, is commonly found a small species of the liverwort genus Riccia. This plant forms fairly extensive mats, and the rhizoids form a dense weft in the surface $\frac{1}{4}$ in. of soil, binding it strongly against erosion. These mats, when dry, impart to the soil a characteristic black, scaly appearance, similar to that produced by excess sodium carbonate (black brak). An important coloniser of small gravel patches formed between the rock outcrops, is the succulent *Stomatium mustellinum*, which forms small, isolated cushions (3 in.—6 in. diam. and 1 in.—2 in. height) seen in Plate 7B. Important pioneers of these coarse gravel areas, also, are the succulents *Ruschia unidens* and

Anacampseros ustulata, while the small tufted grass, *Lepturella capensis* (Plate 7B) is likewise a significant occupant. Here, too, after the first rains of spring, or early summer, spring up and flower Anthericum spp., Dipcadi spp., Eriospermum spp., *Symplegma pulchellum* and other small liliaceous plants, which remain in evidence for but a short while, their aerial parts shrivelling and disappearing upon the advent of summer heat and drought.

Mesembryanthemum spinosum, a rigid shrub, collects wind-blown sand and litter, building up around its base a mound of humous soil. This proves a fertile seed-bed to wandering disseminules which collect there. Being in addition spiny, it acts as a protector, turning away browsing animals, and in its shelter small colonies of other plants, which are seldom met with elsewhere, are developed, as shown in Fig. I. These are *Kleinia radicans*, which produces a prostrate, succulent tangle around the base of *M. spinosum*, interlacing with its lower branches; *Sarcostemma viminale*, which straggles up through the branches, producing in late summer a creamy profusion of blooms; and *Heliophila suavissima* which grows up through the protecting shrub, erecting its violet flowers above. *Sarcostemma viminale* and *Kleinia radicans* do occasionally inhabit other situations; they are found in rock clefts especially, where the former is generally browsed off level with the outer surface of the cleft.

The mounds of soil built up around the base of *M. spinosum* often support as well, small clans of *Cotyledon trigyna*, *Crassula platyphylla*, *Stapelia flavirostris*, *Caralluma lutea*, *Duvalia Corderoyi* and individuals of *Cotyledon decussata*, *Crassula fruticulosa* and *Sutera coerulea*. Occurring here, too, are single tussocks of *Aristida Burkei*, *Eustachys paspaloides*, *Themeda triandra*, *Digitaria eriantha*, an occasional *Cymbopogon plurinodis* and young individuals of *Euphorbia mauritanica*.

2. *Euryops sulcatus—Euphorbia mauritanica.*

This association (Plate 8, and Fig. II) does not differ greatly from the previous one, but, owing to its occupation of somewhat different conditions of soil, certain species, characteristic of the former association, are absent from, or but poorly represented in it, while others that are relatively insignificant in the former, assume here greater significance.

The association is also an inhabitant of the bults, but it occupies slopes less steep than those inhabited by *Mesembryanthemum spinosum—Euphorbia mauritanica*; erosion is less severe, and there is, therefore, a more uniform layer of soil covering the rock, outcrops of which are far less numerous.

With the increase in soil-cover, the grasses, which are of minor significance in *M. spinosum—E. mauritanica,* become much more prominent, and the role of *M. spinosum* in the association is taken over by *Euryops sulcatus.* The grasses (Plate 8) are chiefly *Eragrostis Lehmanniana, E. obtusa,* E. sp. nr. *Atherstonei, Aristida barbicollis, Aristida congesta, A. Burkei, Digitaria eriantha, Themeda triandra,* and in shallower ($1\frac{1}{2}$ in.—2 in.) patches, societies of *Eragrostis denudata* are frequent.

Absent from, or rare in this association, but well represented in *M. spinosum—E. mauritanica,* are the rock-plants *Cotyledon decussata, Cotyledon trigyna, Crassula platyphylla, Stapelia flavirostris, Duvalia Corderoyi, Caralluma lutea* and *Sarcostemma viminale. Heliophila suavissima* occasionally occurs in the shelter of *Euphorbia mauritanica.* Mats of Riccia sp. are abundant among the grasses, while *Geigeria passerinoides* and *Mariscus capensis* are well represented in the association.

3. *Euryops sulcatus—Themeda triandra.*

This association (Plate 9A and Fig. III) occupies two types of habitat, but in both cases it inhabits deeper soil than either of the two preceding associations. It occurs (*a*) on the bults, on slopes only slightly inclined, in brown soil of about 9 inches to $1\frac{1}{2}$ feet in depth ; and (*b*) at lower levels, in depressions and basins, in dark-coloured, alluvial soil ranging in depth from several to over 15 feet. The association is represented, also, in one or two places, on level summits of koppies, where the conditions of soil are similar to those of its bult abode,

Typically, the association is composed of a somewhat mixed Themeda grassveld in which are scattered numerous individuals of *Euryops sulcatus.* With the better development of grass, a number of associated grassveld plants enter the association, *e.g.*, Aster spp., Helichrysum spp., Asclepias spp., *Melolobium candicans, Scabiosa columbaria,* Ipomoea spp., *Convolvulus ulosepalus, Boerhaavia pentandra,* Hibiscus spp., Hermannia spp., *Brunsvigia grandiflora,* and others.

4. *Koppie scrub.*

The fourth and most prominent association (*v.* Map 1) is koppie scrub (Figs. IV and IVA). It generally extends over the summits of koppies and over koppie slopes and valley sides facing north, east and west. Koppie scrub occurs, also, on south-facing slopes, wherever bush is absent. It inhabits shallow talus, the actual depth of which is difficult to ascertain. These situations support a heterogeneous assembly of plants (Fig. IV). All the members of the first two associations are represented here, together with a sprinkling of stunted trees and a number of shrubby forms, more or less restricted to these habitats.

Owing to the local differences in aspect of the habitat—discussed in division (*d*) of this section—koppie scrub shows large variations in the density of its various constituents, but the general constitution of the association remains constant.

The trees found in koppie scrub are mainly stunted individuals of *Olea verrucosa*, *Chilianthus arboreus*, *Euclea lancea*, *Royena microphylla*, *Osyris compressa*, *Ehretia hottentotica* (*rigida*), *Grewia occidentalis*, and *Gymnosporia polyacantha*. Species more or less restricted to the association are *Rhigozum obovatum*, which occasionally forms open societies (Fig. IVA) on the summits, and upper slopes of koppies; *Euclea ovata*, which seldom exceeds a height of 4 feet, being constantly browsed by stock; *Rhus Burchellii*, rarely found in koppie bush; *Euryops multifidus*, almost entirely restricted to koppie scrub; and *Pachypodium succulentum*, found in rocky situations on the summits of koppies. Though a dominant of *Rhus ciliata—Themeda triandra*, the former plant is a prominent member of koppie scrub. A rich variety of grasses is present in the association; all those mentioned for the previous communities, together with a number of additional species, such as *Enneapogon scoparius*, *Eragrostis superba*, *Heteropogon contortus*, *Triraphis andropogonoides*, *Trichoneura grandiglumis*, and a few others. Chomophytes are well represented; the number of individuals is large. The most important are: *Notholaena Eckloniana*, *Pellaea hastata*, *Sarcostemma viminale*, *Cotyledon trigyna*, *Anacampseros telephiastrum*, *A. filamentosa*, *Indigofera Zeyheri*, *Euphorbia aspericaulis*, *E. caterviflora*, *Phyllanthus maderaspatensis* and *Kleinia radicans*. Very characteristic of the association is *Aloe grandidentata* which forms numerous small clans on koppie slopes and summits; their clusters of flame-coloured flowers, in winter, go far towards relieving the monotony of the view. Small, stunted individuals of *Olea verrucosa* often play here the same role as *Mesembryanthemum spinosum* (see *Mesembryanthemum spinosum—Euphorbia mauritanica*) in encouraging the development of colonies of *Kleinia radicans* and *Sarcostemma viminale* within their shelter.

5. *Rhus ciliata—Themeda triandra.*

This association (Plate 9B) occupies the lower slopes of koppies, and fringes the outer edges of bults, abutting on the grassveld surrounding the Area. It is found, occasionally towards the interior of the Area (*vide* Map 1), on the lower slopes of koppies where the soil is more uniform, favouring the development of grassveld.

The association is simple in composition, and similar in form and habit, to *Euryops sulcatus—Themeda triandra*. It is composed of a mixed *Themeda* grassveld in which are unevenly scattered, at intervals

ranging from a few feet to more than 20 yards, individuals and clumps of *Rhus ciliata*, from 2 to 4 feet in height and 3 to 12 feet diameter. Associated with the grasses are the usual grassveld plants enumerated for the *Euryops sulcatus—Themeda triandra* association.

6. *Koppie Bush.*

On steep* slopes of koppies and valleys, facing south and south-east, and along the sides of rocky dongas among the koppies, the trees of koppie scrub have developed, to the exclusion of the other scrub members, to form semi-close stands of bush. As mentioned earlier in this paper small stands of koppie bush occasionally occur also on east-facing slopes, where these are steeply inclined. The association always inhabits deep talus.

From Fig. V it is seen that koppie bush forms a semi-close community in which *Olea verrucosa*, *Chilianthus arboreus*, *Cussonia paniculata* and *Grewia occidentalis* are the chief trees. The crowns of *O. verrucosa*, *C. arboreus* and *G. occidentalis* form a more or less broken canopy, 10 to 14 feet in height, and grey-green in colour. Through it protrude, at varying intervals, the paler blue-green crowns of *Cussonia paniculata* (14 ft.—16 ft. height). *Heteromorpha arborescens* and *Euclea lanceolata* are also represented in the bush.

The association is possessed of a fairly rich undergrowth. Beneath the crowns of the trees are found numerous plants of all sizes ; these can be grouped into two layers (Fig. V) (*a*) those between $3\frac{1}{2}$ and $6\frac{1}{2}$ feet in height, comprising saplings of the trees forming the upper layer, the small trees (or tall shrubs) *Gymnosporia polyacantha* and *Ehretia hottentotica* and the shade-plant *Cluytia pulchella;* and (*b*) those below $3\frac{1}{2}$ feet : seedlings of the trees and shrubs and herbaceous plants.

With the development of bush a number of sciophilous (shade-loving) species have made their appearance. These are : *Solanum nigrum*, *Cluytia pulchella*, *Eucomis undulata* (a shade-plant of tall grass), *Crassula nodulosa*, *Crassula Cooperi* var. *robusta*, and the grasses *Panicum deustum*, *Ehrharta erecta* and *Setaria verticillata*. Here, too, occur Asparagus spp., *Kleinia radicans*, and *Sarcostemma viminale*. In late summer and in autumn the floor of the bush becomes clothed by dense stands of the small *Crassula muscosa*. Rock-surfaces and crevices are inhabited by numerous Cyanophyceae, small crustaceous lichens, the liverworts, *Targionia hypophylla*, *Fimbriaria marginata*, *Plagiochasma rupestre*, *Fossombronia pusilla*, Riccia spp., *Trichostomum brachystomum* and a few others, several shade-loving ferns, especially *Cheilanthes hirta* and

* By " steep " is meant a slope of 25°—30° to the horizontal.

Ceterach cordatum, and the mosses Bryum spp., *Ptychomitrium cucullatifolium*, *Tortula pilifera*, *T. atroviridis*, Entosthodon spp., and several undetermined species.

The trunks of the trees, especially those of *Olea verrucosa*, are often sparsely clothed by several species of crustaceous lichens. Olea often bears on its branches a number of individuals of the parasite *Viscum pauciflorum*.

Owing to the interrupted nature of the canopy a number of typically heliophilous species enter koppie bush, occupying the illuminated patches of the floor ; these are *Crassula platyphylla*, *Cotyledon trigyna*, *C. decussata*, *Aloe grandidentata* (very much etiolated) and *Stapelia flavirostris*.

On the whole the shade cast by koppie bush is not dense ; the average light intensity for the association, as calculated from 15 readings taken in January, in several different stands, was 13.33 per cent. of full sunlight.

7. *Spruit-bank-valley bush.*

As the rocky dongas are descended, and the deep alluvial soils of the valleys encountered, koppie bush becomes mixed with, and finally gives way to a new bush community, which we have called spruit-bank-valley bush (Plates 6A, 10A, Fig. VI, Map 1). The soil may reach a depth here of over 25 feet. *Olea verrucosa* still persists in the association as an important member ; *Gymnosporia polyacantha* is also a component, while an occasional *Chilianthus arboreus* is found to stray into the community.

Spruit-bank-valley bush, as its name suggests, clothes the banks of spruits and sloots which wander down the valleys. Isolated clumps of this bush are found also dotted about the valley floors, giving to them a park-like appearance (Plate 6A). The bush lining the banks of the spruits forms an irregular, usually open community (Plate 10A), but in a few places it forms closed communities (Fig. VI). The association is built up of a number of species of trees which vary considerably as to height ; and it cannot be said that any particular species are dominant for the association as a whole. Some are more conspicuous than others by reason of their superior stature ; *Celtis rhamnifolia* occasionally exceeds a height of 25 feet, *Rhus lancea* may attain to 20 feet or more, and in rare instances individuals of *Zizyphus mucronata* of about the same height have been recorded, while *Olea verrucosa* often reaches a height of 18 feet along the spruits. For the rest the bush seldom exceeds a height of 12 feet.

The bush clumps dotted about the valley floors are usually dominated by one or two large individuals of *Celtis rhamnifolia*, *Zizyphus mucronata*, or *Rhus lancea* ; beneath and around these is developed a dense, interlocked growth of *Royena decidua*, *Rhus pyroides*, young trees of *Zizyphus*

mucronata, and an occasional *Olea verrucosa*. In the areas between the clumps are usually developed luxuriant glades of valley grassland. Around the fringes of the clumps and scattered through the grass glades is found the " wildeals " (*Artemisia afra*). So prominent was this plant at one time that the farm Wildealskloof* (*v.* Map 1) was named after it.

The shade cast by closed portions of the bush is dense (4.81 per cent. of full sunlight). The ground vegetation is, as a result, rather sparse (*v.* Fig. VI). The undergrowth is composed chiefly of seedlings and saplings of the trees, seedlings and young plants of the liane *Clematis Thunbergii*, species of Asparagus, scattered individuals of *Senecio glanduloso-pilosus*, *Achyranthes aspera*, *Solanum nigrum*, *Tagetes minuta* and the grass *Ehrharta erecta*.

Clematis Thunbergii is very well developed in the association, and often seriously threatens the well-being of the trees supporting it. Very richly developed, too, is the parasite *Viscum pauciflorum* which shows a marked preference for *Olea verrucosa*. *Rhus lancea*, it has been noticed, is always free from the parasite, and seeds of Viscum placed on this host have not germinated.

8. *Acacia bush.*

(Plates 10B, 11 and Fig. VII).

Near the mouths of the valleys, where the gradient is slight, the spruits are considerably reduced in depth and in width ; small flushes are formed, and the soil may reach depths of over 40 feet. As the flushes are approached from the upper reaches of the valleys, spruit-bank-valley bush rapidly gives way to Acacia bush (*v.* Map 1). Plate 10B shows a stand of this bush following a flush.

Acacia bush is relatively simple in composition (*vide* Fig. VII†); it is composed of closed stands of *Acacia karroo*, and beneath the trees is a ground vegetation, poor in species. The trees are from 14 to 20 feet in height, their crowns are by no means densely branched (Plate 11) and the shade cast by them is, in consequence, less deep than that of the above association ; the average light intensity for the community, observed in January, was 10·03 per cent. full sunlight.

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* The Wildealskloof of to-day is the remnant of a large farm of this name, which originally comprised, as well, the farms Stathearn, Tredenham and Mooihoek.

† The small stand of bush marked by the Figure VII in Map 1 was chosen for the transect on account of its undisturbed condition, due to its having been fenced off from stock since 1915. Much damage is done by stock to the ground vegetation of Acacia bush in other locations.

Owing to the more favourable intensity of light, further augmented by the deciduous nature of *Acacia karroo*, the bush floor is covered by close stands of the grasses *Bromus unioloides*, *Ehrharta erecta* and tussocks of *Panicum deustum*. For the rest the undergrowth is comprised of seedlings and saplings of *Celtis rhamnifolia*, *Zizyphus mucronata*, *Rhus lancea*, *Rhus pyroides*, *Royena decidua* ; of the shade-plants, *Solanum nigrum*, *Achyranthes aspera*, Asparagus spp., Lycium sp., and *Tagetes minuta*. Seedlings and saplings of *Acacia karroo* are rarely encountered ; the reason for their absence is discussed in division (*d*) of this section.

9. *Valley grassland.*

As previously noted valley grassland occupies the sides of watercourses, small flushes (where Acacia bush is not developed), and areas between the clumps of bush in the valleys. In general, the association is of a hygro-mesophytic nature, forming luxuriant stands in normal seasons. It is composed chiefly of the grasses *Eragrostis nebulosa*, *Panicum minus* var. *planifolium*, *Pennisetum sphacelatum*, *Diplachne fusca*, *Eragrostis plana*, *E. margaritacea*, *Themeda triandra* and *Sporobolus fimbriatus*, with an occasional tussock of *Cymbopogon plurinodis* ; the sedges Scirpus spp., Cyperus spp., Mariscus spp., and two species of Juncus, *J. rupestris* and *J. exsertus*, are frequently represented. When in flower the grasses vary in height from 3 to 5 feet. Where the grass is closely cropped, numerous herbaceous plants—especially prominent in spring—are found associated with the grasses. Some of these are Lobelia spp., *Wahlenbergia arenaria*, *W. nudicaulis*, Helichrysum spp., *Ifloga paronychioides*, Sebaea spp., *Diclis petiolaris*, *Manulea Benthamiana*, *Anchusa capensis*, Oldenlandia (*Hedyotis stricta*), *Tournefortia tuberculosa*, *Scabiosa columbaria*, the half-shrub *Sida cordifola* and the geophytes *Homeria pallida*, *H. aurantiaca*, Moraea spp., Bulbine spp., Anthericum spp., Scilla spp., and *Gladiolus edulis*. *Eucomis undulata* occurs as a shade plant in tall grass.

(*c*) The Relationships of the Associations.

Starting from bare rock on the one hand and from water on the other, and assuming that succession always tends towards the mesophytic one can theoretically connect up most of the associations of the Area in two series converging into Themeda Grassveld. Such a dynamic scheme (*v.* Phillips, 1930) if correct would be a useful guide, but sufficient evidence has not yet been obtained from the vegetation to enable such a scheme to be drafted. There are too many gaps in the evidence, and some of the evidence seems conflicting. For instance the habitat of Acacia

bush seems more favourable to plant growth than that of the Spruit-bank-valley bush, and the Acacia bush gives the general impression of being dynamically a more advanced community. Yet it is being invaded by members of the other association. The cutting of firewood from the Acacia bush and the influence of grazing animals may be determining factors, but this is not yet certain. From the evidence of local farmers this displacement is known to have happened before, but again the effect of man's interference is uncertain.

(*d*) Factors.

Mesembryanthemum spinosum—Euphorbia mauritanica.

This association occupies the most adverse habitat to be found in the Area. The small patches of soil on the rocky slopes are exceedingly shallow, and composed of coarse sand and gravel ; their water-retaining capacity is consequently very low and the run-off is enormous. The slopes are fully exposed to the desiccating effects of sun and wind. The effect of insolation is intensified by the shallowness of the soil and the abundance of exposed rock-surfaces. Soil temperatures above 40°C. have been recorded in summer while the temperature of rock-faces may rise above 60°C. Only the most hardy and highly adapted plants are able to endure on these slopes. *Mesembryanthemum spinosum*, though a leaf-succulent, sheds about two-thirds of its foliage during hot, rainless periods ; *Euryops sulcatus* retains only its youngest leaves—the branches being naked usually to within a few inches of the tips ; and *Euphorbia mauritanica*, a stem-succulent, sheds its leaves shortly after their development in spring. During periods of heat and drought, growth of the vegetation ceases, the grasses shrivel and brown, and the association, as a whole, enters into a state of suspended animation.

Euryops sulcatus—Euphorbia mauritanica.

The habitat conditions of this association are essentially similar to those of the previous one ; the slopes, however, are less steep with the result that run-off and consequent erosion is less severe. As a result there is a more uniform and somewhat deeper soil-cover on these slopes, and it is this factor which determines the differences in the vegetation of the two associations. The more uniform soil-cover encourages stronger development of grasses, and although we have found no direct evidence to this effect, it is probably due to the richer grass development that *Mesembryanthemum spinosum*—a plant sensitive to shading—is absent from the association.

Euryops sulcatus—Themeda triandra.

As mentioned earlier in this paper, *Euryops sulcatus—Themeda triandra* inhabits deeper soil than either of the above two associations. The deeper soil and consequent higher water-capacity has caused the development of a good growth of grass which apparently is responsible for the exclusion of *Euphorbia mauritanica*. It has been noted also, that the association inhabits two types of soil: (1) brown, sandy soil on bults, 9 inches to 1½ feet deep; and (2) dark, alluvial soil in basins and depressions, sometimes over 15 feet deep. Evidence suggests that the original abode of *Euryops sulcatus* was on the bults, and that the influence of man, combined with periodic droughts has been responsible for its recent spread into the lower levels which originally supported pure grassland. Several of the older inhabitants of the Area have been questioned concerning the distribution of *Euryops* in the past, and although the information obtained from this source is somewhat vague and conflicting, the general impressions appear to be in accordance with what has just been said.

The chief factor encouraging the spread of *Euryops* is man. His herds and flocks, by grazing off, and trampling out the grass, enable the resin-bush, which is highly unpalatable to stock, to penetrate readily into the valleys from which it was formerly kept out by the luxuriance of the grass. The invasion of *Euryops* is greatly facilitated by its flowering habit; it flowers abundantly and produces seed copiously after every rain, in winter as well as in summer. Plate 9A shows a heavily-grazed portion of grass-veld in which *Euryops sulcatus* has become thickly established. From its situation, viz., low-lying area with deep alluvial soil, watered from the upper slopes, one is led to suppose that the site originally supported valley grassland. In some instances *Euryops* has penetrated into bush communities in the valleys.

An interesting parallel to the behaviour and spread of *Euryops sulcatus* in the Area has been reported from a certain farm in the Thaba 'Nchu district, which, due to over-stocking and burning, has recently become heavily invaded by the resin-bush.

During the past two years, in areas that have been protected from stock, or only lightly grazed (Fig. III) the grass has made luxuriant growth, and threatens to "choke out" the resin-bush. If these areas are protected for several more years it is quite probable that *Euryops* will be completely ousted. On the bults, however, the drier conditions are less suitable to a dense development of grass, so that here an equilibrium is established between *Euryops* and *Themeda*.

Koppie Scrub.

Except for the eastern faces of koppies which are more protected and which frequently have developed on them small patches of bush, koppie scrub inhabits, in point of exposure to insolation and to drying winds, situations as adverse as those of the first two associations dealt with. The factor responsible for its richer development, both in number of species and of individuals, is the depth of the soil ; this is a shallow talus of uncertain depth, but nevertheless considerably deeper than the soils of the above two associations.

As previously noted, koppie scrub varies in density according to its particular aspect. On easterly slopes insolation is less intense with the result that a closer growth of trees and shrubs takes place, and it may even proceed to bush. On north-westerly slopes, on the other hand, the drying effects of wind and sun are more intense, and erosion more severe. Here, a richer development of the succulent scrub and of xerophytic grasses, notably *Aristidas* and species of *Eragrostis*, is usually found.

Rhus ciliata—Themeda triandra.

This community is in a rather disturbed state ; over-stocking, combined with the recent severe droughts has led largely to the replacement of *Themeda* by species of *Aristida* and *Eragrostis*. As Bews (1918) puts it, the grassveld has been thrown back to the earlier stages of the succession. *Themeda triandra* is, however, again making rapid advance on situations where grazing is not severe.

Koppie Bush.

The restriction of koppie bush to slopes facing south or south-east, and its almost complete absence from other slopes is a striking feature of the Area. Plates 12A, 12B and Fig. X illustrate this. The differences between the vegetation of slopes facing south and of those facing north have attracted the attention of ecologists in many countries. These differences are generally attributed to the differences in climate found on the slopes, but whether the climate is the direct factor, or whether it is only indirectly responsible, is not generally stated. For the most part, the differences in the vegetation are simply correlated with the differences in climate. Aitken (1922) for example made a detailed comparison of insolation, temperature ranges, and soil moisture of the north and south slopes of a hill near Maritzburg, and having found marked differences in climate, he correlated with them the differences in the vegetation. Similar observations were made on slopes X and Y, Fig. X,

and similar results obtained (Figs. XI—XVI). We were curious to know, however, whether the effects of climate are direct or only indirect. We therefore set out to obtain evidence concerning this point, and have concluded that, in the area under discussion, the effect of the climate in the limitation of bush to south-facing slopes is indirect. The following observations were responsible for this conclusion :

1. On the farm Wildealskloof (*vide* Map 1) there is a koppie with bush developed on three sides—north-west, north, and east.

2. On the summit of a bult on Bayswater there is a small, completely isolated ring of bush (*vide* Plate 13A) developed in the collapsed walls of an old military sconce.

3. On the top of a bult on Hillside there is another small, isolated clump of bush. (Plate 13B.)

It was obvious, then, that the climate could not be the factor directly responsible for the absence of bush on bults, and on the slopes of koppies which face north or west, or bush would not have been able to develop on the above stations. It remained then to discover the factor directly governing the distribution of koppie bush. With this object in view the soils of south-facing slopes were compared with those of other slopes. Considerable difference was found to exist. The soil of the former is a "rough" talus giving the impression of considerable depth ; large irregular boulders and rocks jut out at different angles and the interspaces are filled with dark humous soil. Soil-filled rock-clefts several feet in depth are often visible. The soil of slopes facing north and west, on the other hand, though also talus, is more uniform ; the boulders are smaller, more regular, and usually somewhat rounded ; the actual soil-cover itself is more uniform and appears to be quite shallow.* Further investigation has shown that wherever koppie bush occurs, whether on northern or western slopes, as in observation 1, or whether in small patches on eastern slopes, or in its usual position on southern slopes, it invariably inhabits deep talus of the type described above. The question now arises whether it is the type of soil which is responsible for the development of the bush, or whether the presence of bush is responsible for the development of the soil type. Investigation of the soil conditions in observations 2 and 3 above, supports the former alternative. In 2 the broken-down sconce-walls have collected drift-sand, and in this way a deep talus-like soil has been built up. In 3 the same effect has been obtained from blasting† of the surface rock, and accumu-

* We regret that actual figures of depth cannot be given as the measurement o talus soils involves considerable labour.

† Some time in the past blasting for the purpose of obtaining road-metal was commenced on this site, but for some reason the spot was abandoned and a quarry cut a short distance west of it.

lation of drift-sand by the resulting rubble. The above two observations are of the nature of actual experiment, and in both cases it is quite obvious that it is the soil type which is responsible for the development of bush on these stations, and not *vice versa*.

Having concluded that it is the *edaphic* factor which directly controls the distribution of koppie bush, a further consideration comes to mind, namely, that of drainage and seepage, but as the whole Area is composed of an unstratified doleritic boss, this consideration does not obtain.

Figs. XI—XVI show clearly the disparity between the climates of slopes facing south and of those facing north. Yet the fact that koppie bush occasionally occurs elsewhere than on slopes with a southerly aspect shows that factors other than the direct action of climate on the vegetation are operative. Climate is probably of great importance indirectly in determining the depth and type of soil produced on different slopes and, regarding this, Professor W. von Bonde has given the following explanation of the presence of a deep rubble-soil on the southern slopes of koppies : " All accumulations are due in the first instance primarily to frost action and insolation. The lesser depths of the talus on north slopes as compared with south slopes are due to the more rapid removal of the products of weathering from north slopes by torrential rains which almost invariably fall from N.E., N. or N.W. before strong driving winds. The northern ' runs off ' is therefore rapid and little ' sinking in ' occurs. On the southern slopes, on the other hand, the ' run off ' is less and hence the ' sinking in ' is more gradual ; hence there is a greater tendency for chemical action to produce soil. The constant accumulation therefore of rock-rubble due to frost action and insolation together with chemically produced soil gives the southern slopes of koppies a greater amount of rubble-soil accumulation than is found on the northern slopes.

It must also be borne in mind that the ' towards the sun ' aspect of the northern slopes favours a drying out action by the sun, whereas the southern slopes turned away from the sun tend to retain their moisture for a longer period, therefore favouring chemical decomposition of rock-rubble. Hence it is obvious that :—

(1) Southern slopes have a deep dominantly chemically-produced soil of fair humidity content.

(2) Northern slopes have a shallow dominantly physically-produced soil of low humidity content."

It seems therefore that the usual restriction of Koppie Bush to slopes facing south or south-east is due to climate, and that this factor acts indirectly by determining the character of the soil. But the direct action of climate on the vegetation must govern the luxuriance of the Bush.

Plate 13B shows that by creating a deeper talus it is possible to cause stands of bush to develop where bush does not normally occur. Could this idea be applied on a small scale in planting patches of trees in the extensive treeless areas of the Orange Free State? Blasting which has been used to open up rocky ground in preparation for tree planting no doubt acts by enabling air and water to penetrate deeply, and must in time result in the production of a deep layer of chemically-produced soil.

Spruit-bank-valley bush.

The factor concerned in the distribution of this association is moisture which is itself dependent upon the depth of soil and topographical position of the habitat. The valleys with their spruits receive, as run-off and drainage, a large part of the rain falling upon the adjacent slopes, and are consequently, by comparison with other habitats, relatively moist. Below is a table showing the averages of a number of moisture-content determinations made in different associations. The samples were taken at a depth of two inches, two days after a rainfall of 0·5 inch.

TABLE III.

Comparison of the soil-moisture contents, at 2 inches depth, in different associations after a rainfall of 0·5 inch.

Mesembryanthemum spinosum—Euphorbia mauritanica ..	4·35%
Euryops sulcatus—Euphorbia mauritanica	4·97%
Euryops sulcatus—Themeda triandra	10·24%
Koppie scrub	6·82%
Rhus ciliata—Themeda triandra	8·63%
Koppie bush	12·98%
Spruit-bank-valley bush	13·44%
Acacia bush	13·89%
Valley grassland	wet

As mentioned earlier in this paper, the soil of spruit-bank-valley bush may reach depths of over 25 feet. Although the surface shows an acid reaction, a true picture of the soil is obtained only by an examination of its profile. A section of the wall of a spruit 10 feet in depth comprised 4 distinct horizons as regards reaction. The first, 12 inches thick, slightly acid; the second, 18 inches thick, neutral; the third, 4 feet thick, strongly alkaline; the fourth zone, 3½ feet thick, neutral in reaction. The acidity of the first horizon is probably due

to the leaching out of the soluble salts, which accumulating in the third horizon form a type of podsol. Roots occur throughout all these horizons.

Acacia bush.

Towards the mouths of the valleys where the gradient is considerably reduced the spruits form flushes as described by Bews (1916). The rate of flow of water is checked causing deposition of suspended matter. Soils up to 4·0 feet deep have been formed and these are usually more moist than those higher up the valleys (*vide* Table 7). *Acacia* bush follows the flushes.

Bews (1925), and Galpin (1926) have made the observation that *Acacias* are usually found on soil rich in lime, but down to a depth of 3 feet this soil continued to show an acid reaction.

Acacia bush shows signs of being displaced by spruit-bank-valley bush although normally one would expect the succession to be the reverse of this. Seedlings and saplings of *Celtis rhamnifolia* are numerous, while thriving young plants of *Royena decidua, Rhus lancea, Zizyphus mucronata* and *Rhus pyroides* are also found. Large trees, however, of the above species are rare. We may assume, therefore, that in recent years some change has taken place in the association allowing the entrance of spruit-bank-valley bush species. The cause of this is not yet known. Young trees and seedlings of *Acacia karroo* are scarce. This may be partly due to the fact that when the trees flower in summer the inflorescences and young pods become heavily infested with the rust-fungus *Ravenalia MacOwaniana* which causes gall-like growths, inhibiting seed production.

A large percentage of the older trees of *Acacia karroo* are severely attacked by a borer-grub, the larva of *Macrotoma palmata Fbr.*, and where an old tree has died, in the clearing produced, a dense stand of young individuals of the spruit-bank-valley bush association is found.

Valley grassland.

From what has been said concerning its habitat, it will be realised that moisture and depth of soil are the factors concerned in the distribution of valley grassland. Though generally luxuriant, the richness in species of any particular stand is dependent upon the water supply of the soil. From its distribution it will be realised that although the association always inhabits relatively moist situations, the degree of moisture varies from stand to stand. The flushes are more moist than the watercourses, and in a single flush even, variations in moisture are considerable. Figs. VIII and IX show the zonation of species in two

flushes, the soil becoming progressively drier from the centre outwards. Thus the flushes are richer in species than are the somewhat drier watercourses. In the flushes the more hygrophytic species, including *Eragrostis nebulosa, Panicum minus var. planifolium, Pennisetum sphacelatum, Diplachne fusca*, are most in evidence. Along the watercourses *Themeda triandra, Digitaria eriantha* and a few others predominate, while a scattering of the above species is also usually present.

Fire.

During the past twenty years at least fire has had very little effect on the vegetation of the Area. This is to be ascribed partly to heavy grazing, partly to the open character of most of the vegetation and partly to the fact that the few bush and grass communities that are relatively dense occur in small patches.

Soil the Controlling Factor.

The climate, geology, and topography have co-operated in the production of a number of varied and relatively stable soil types, and it is these which determine the distribution of the associations. Soil-depth particularly, with its increase or decrease in water-content, is the important factor. The direct effect of topography on soil-moisture must not be overlooked, however, as those soils most favoured as regards depth are also (with the exception of the soil of koppie bush) the soils most favourably placed with regard to water supply ; the deep alluvial soils of the valleys and depressions receive a large portion of the rain which falls upon the slopes.

(*e*) The Succession.

There are two distinct lines of succession followed in the area investigated :

(1) Commencing on bare rock surfaces (*lithosere*).

(2) Commencing in water (*hydrosere*).

Of the first line of succession there are two types, dependent upon aspect : (i) the moist type which proceeds on slopes of koppies and dongas facing south and south-east ; and (ii) the dry type on slopes facing north and west.

(1) *Lithosere.*

(i) Moist type. On the faces (chiefly southern) of rocks on donga-sides and koppie-slopes facing south, the first plants to gain foothold are unicellular *Cyanophyceae*. Following, or entering at the same time as these are a number of colonies of small crustaceous lichens. These

pioneers disintegrate the rock in patches, producing a rough, mottled surface. At this stage several mosses, notably *Ptychomitrium cucullatifolium*, *Tortula pilifera* and *Bryum mundii* are able to secure a footing. Of these the xerophytic *Ptychomitrium* is the most significant. It forms mats ½ to 1 inch thick on the shady sides of rocks. Its lower parts, which die off, collect wind-blown sand, and silt, and in this way a thin layer of humous soil is held in position on the rock-face. In the moss mats, now become established the ferns *Cheilanthes hirta* and *Ceterach cordatum*. At this stage in the succession, splitting of the rock is generally found to take place. The first plants to enter the crevices are liverworts, *Riccia albomarginata* and *Trichostomum brachystomum* chiefly. They form fairly extensive mats and bind any sand or debris which may have collected in the chinks of the rocks. As the crevices become widened, chasmophytic ferns (*Notholaena Eckloniana*, *Cheilanthes hirta*, *Pellaea hastata*) and grasses (*Eustachys paspaloides*, *Rhynchelytrum roseum*, and several others), invade the liverwort mats and assist in thes oil-building process. Other chomophytes (rock-detritus plants) now enter. These are, *Sarcostemma viminale*, *Phyllanthus maderaspatensis*, *Indigofera Zeyheri*, *Kleinia radicans*, *Anacampseros filamentosa*, *A. telephiastrum*, *Cotyledon trigyna*, *Crassula platyphylla*, *Euphorbia aspericaulis*, and *E. caterviflora*. *Euryops multifidus*, and several other shrubs now make their appearance. The rocks, after being further prized apart, and after sufficient soil has collected in the interspaces, will present a sub-stratum of talus type suitable for bush colonisation.

(ii) Dry type. The dry type of the lithoseric succession differs from the moist type in not having either the moss or the liverwort stages represented ; the ferns *Ceterach cordatum* and *Cheilanthes hirta*, important members of the moist type, do not find a place in the succession, while the chasmophytes *Sarcostemma viminale*, *Kleinia radicans* and *Phyllanthus maderaspatensis* are rare in it. If the succession is proceeding on the bults, the shrubs *Euryops sulcatus*, *Eriocephalus spinescens* and *Mesembryanthemum spinosum* enter upon the chasmophytic stage, and if proceeding on the koppies, *Euryops multifidus*, *Euclea ovata* and other scrub species also settle in. The succession has now reached its climax except for one late arrival, *Euphorbia mauritanica*, which develops in the protection of the above shrubs. It usually displaces *Eriocephalus*, but although it generally grows taller than either *Mesembryanthemum* or *Euryops* it is seldom able to displace them, but kills by shading those portions of the plants which it surrounds.

Small areas of gravel, ½ to 1½ inches in depth, collect about the margins and in depressions of rock outcrops on the bults. The earliest

colonists of these gravel patches are the cushion plant *Stomatium mustellinum* and the small tufted grass *Lepturella capensis* (Plate 7B); others are *Ruschia unidens*, *Anacampseros ustulata* and occasionally *A. filamentosa*. After these plants have assisted further in the weathering of the gravel, the patches become invaded and closely colonised by the grasses *Eragrostis denudata*, *Tragus koelerioides* and species of *Aristida*.

(2) *Hydrosere.*

The succession, as pieced together from a study of small ponds of standing water in the flushes, is as follows: Species of the green alga *Spirogyra* are the first to make their appearance. They form large blankets on the surface of the water and are also found submerged, attached to stones and debris. When well developed, the algae may almost fill the pond. Various aquatics now make their appearance. These are banded into zones:

(i) Fairly deep water, 1-3 feet. Here are found two types:
  A. Submerged and rooted (*Chara spp.*).
  B. Rooted, with submerged leaves and aerial inflorescences (*Lagarosiphon muscoides*, *Potamogeton pusillum*).

(ii) Shallow water, 4-12 inches. Again two types are represented:
  A. Rooted in soil with floating leaves (*Marsilea macrocarpa*) and with free aerial inflorescences (*Limosella aquatica var. tenuifolia*).
  B. Rooted in soil with free aerial leaves and inflorescences (*Polygonum lapathifolium* and the sedges *Scirpus spp.*, *Cyperus spp.* and *Mariscus spp.*).

(iii) Wet soil around the margins of ponds is inhabited by a number of *Cyperaceae* and the grasses *Eragrostis nebulosa*, *Panicum minus var. planifolium*, *Pennisetum sphacelatum* and *Diplachne fusca* chiefly (*vide* Fig. VIII). Passing outwards into drier soil these are replaced by mesophytic, and in fact, somewhat xerophytic species (*Themeda triandra*, *Digitaria eriantha*, *Sporobolus fimbriatus* and others).

Succession in Grassland.

Protection from grazing could not be arranged in the Area but the Council of the University College of the O.F.S. very willingly set aside for Pasture Research and fenced off a number of small grass camps in the College grounds. Twelve quadrats were laid down and were charted in March, 1934, and again in March, 1935. It was hoped that by the selection of a series of plots in successive stages of development along

the anticipated line of succession, the course of the succession might be confirmed in a single growing season. In this respect the results were disappointing, but arrangements have been made to continue the quadrats for several years.

During the twelve months only one quadrat showed an appreciable degree of progressive succession: *Themeda* advanced at the expense of *Digitaria*, both in number and size of the tussocks, resulting in an increase of the grass-cover. Another showed the colonisation of a bare area by but two individuals (of the annual, *Tragus racemosus*). In most of the other quadrats there was a complete or partial loss of annuals (grass and others) which was not compensated for by the increase in size of the surviving perennials so that the net result was a decrease in the vegetable cover.

The disappointing results are to be attributed to the season which was unfavourable to the growth of grass, for although 19·68 inches of rain were recorded for the period October 1st, 1934, to March 31st, 1935, only 3·79 inches were recorded during the period December 22nd, 1934, to March 20th, 1935. Thus the best part of the growing season was practically rainless. The dryness of the season was further aggravated by a succession of hot desiccating winds following upon precipitation.

A study of the reaction of the vegetation to various disturbances as found in the cultivated and otherwise disturbed parts of the Area was also begun. Here again, to ensure protection from grazing, plots were laid down in the grounds of the University College. As yet there is nothing to report.

(*f*) Seasonal Aspects.

There are five more or less well-defined flowering aspects: hibernal, prevernal, vernal, aestival and autumnal. In the case of some of the plants named, especially the geophytes there is a general flowering as a rule only at intervals of several years.

1. Hibernal (June-August). The period June-August is characterised by the flowering of *Aloe grandidentata*. Rocky slopes and koppie summits are mottled with colour: the flame-coloured flower-clusters of the *Aloe* show up brightly against a background of bleached grass tussocks. *Rhus lancea* blooms at this time too, but its flowers are inconspicuous.

2. Prevernal (August-September). During this period, before the termination of frosts, *Euryops multifidus* and *Euphorbia mauritanica* come into flower. The latter is especially prominent, its yellow inflores-

cences co-mingling with the pink of the aloe rearguard do much towards brightening the view. To this is added, in late September, a mauve hue by *Mesembryanthemum spinosum* so that the bults and koppies become at this period distinctly colourful. At this time, too, are found groups of the mauve-flowered shrub, *Aster fruticulosa*, blooming profusely, while *Pachypodium succulentum*, *Pterodiscus speciosus* and *Chrysocoma tenuifolia* add a further sprinkling of colour. The prevernal is the brightest and best defined of the flowering aspects.

3. Vernal (September-November). With the rise of temperatures in spring the deciduous trees don their foliage and commence flowering, but with the exception of *Grewia occidentalis*, *Royena decidua* and *R. microphylla*, the flowers are inconspicuous. Provided the season is not too dry, *Chilianthus arboreus* makes a very brave show of creamy-white against the south-facing slopes of koppies, while the flushes are transformed into bright gold by the flowering of *Acacia karroo*. In grassland areas numerous herbaceous plants such as *helichrysums*, *lobelias*, *asclepiads*, *sebaeas* and many others come into flower while *homerias* and *moraeas* are also in evidence. In rocky ground the geophytes, *Ammocharis falcata*, *Bulbine spp.*, *Haemanthus hirsutus*, *Buphane toxicaria*, *Hypoxis spp.*, add colour to the season ; rocky watercourses are made quite showy by the numerous flowers of *Tulbaghia acutiloba* and *Dipcadi spp.* ; *Sesamum capense* exhibits its mauve flowers in varied habitats ; and scattered shrubs of the orange-flowered *Hermannia Rehmannii* are not inconspicuous at this season. When in flower, the drie doorn (*Rhigozum obovatum*) with its golden yellow flowers, which usually appear in October and November, is probably the showiest of the wild shrubs growing near Bloemfontein, but like so many other members of the native flora it does not flower profusely every year. Being somewhat rare here it is little known.

4. Aestival (November-March). Summer is not rich in conspicuous flowers. A large number of small herbaceous plants in flower are scattered through the Area. *Euryops sulcatus* blooms sporadically after every shower of rain. The grasses generally flower during this period (provided sufficient rain has fallen) ; the pink, feathery inflorescences of *Rhynchelytrum roseum* are conspicuous especially on bult and koppie summit. Dotted about the Area are seen in flower *Nerine sp. nr. lucida*, *Cotyledon decussata*, *Kalanchoe paniculata*, *Anacampseros spp.*, *Clematis Thunbergii* (along spruits), *Stomatium mustellinum*, *Ruschia unidens* and other *Mesembryeae*. In late summer the reddish-pink flower-heads of *Brunsvigia grandiflora* are met with, while *Sarcostemma viminale* blooms profusely on bult and koppie. On the whole, however, the summer season is not colourful.

5. Autumnal (March-May). Autumn is characterised chiefly by *Nidorella hirta* which converts disturbed grasslands, and fallow lands into seas of bright yellow, and by *Euryops multifidus* which again comes into flower and imparts a yellow hue to koppie slopes. The *Stapelieae* are now in full bloom ; *Selago albida* is fairly prominent, while the small mauve-pink flowers of *Cyphia triphylla* are sprinkled through the grasses on the slopes of bults. *Hessea karooica*, also, is fairly abundant in rocky situations.

(*g*) Raunkiaer's Life Form Spectrum.

In Table 4 are given the life-form spectrum of the flora of the Area, the spectrum of each association, and the normal spectrum. The percentage figure for each form is expressed to the nearest unit.

From the description of the climate, given earlier in this paper, we would have expected, perhaps, to find higher values of H and G in the spectrum of the Area. The high figure for therophytes, however, is in accordance with what we would expect, and this figure would be

TABLE IV

RAUNKIAER'S LIFE-FORM SPECTRUM.

	No. of Species.	S	E	MM	M	N	Ch.	H	G	HH	Th
Normal Spectrum ..	400	1	3	6	17	20	9	27	3	1	13
Spectrum of the Area ..	374	3	..	..	5	9	22	10	12	5	34
Mesembryanthemum spinosum—Euphorbia mauritanica.	46	11	..	..	..	7	30	28	17	..	7
Euryops sulcatus — Euphorbia mauritanica ..	50	6	..	..	..	4	32	34	14	..	10
Euryops sulcatus—Themeda triandra ..	55	6	..	..	..	4	16	33	16	..	26
Koppie scrub	79	13	..	..	14	10	13	30	10	..	10
Rhus ciliata — Themeda triandra	40	5	..	..	..	3	13	35	8	..	37
Koppie bush	38	8	..	..	21	8	13	21	13	..	16
Spruit-bank-valley bush	30	..	..	3	23	10	17	20	3	..	24
Acacia bush	20	..	..	5	25	15	..	15	10	..	30
Valley grassland ..	60	..	..	..	..	..	..	35	15	30	20

still higher were all the ruderals and weeds of cultivated portions included. The relatively high (compared with the figure in the normal spectrum) value for HH may occasion some surprise, but, from what has gone before, it will be realised that it is the topography of the Area, rather than the climate, which is responsible for this.

A similar criticism to that embodied in a reply by Raunkiaer (1934, p. 190) to Warming's observations regarding the Brazilian Campos may be levelled against this treatment of the subject since the climate of the Bloemfontein district—and one might include the whole of the central portion of the Orange Free State—is more or less uniform, the spectrum, to give a reliable picture of the plant climate, must be calculated from all the species of the whole area instead of from one very small part of it. It would seem then that we must first, by meteorological methods, determine the climatic limits of an area or region before we attempt to work out the spectrum for it. The fact remains, however, as Warming has indicated, that within a given region having a uniform climate, although the spectrum worked out for the region as a whole may afford a reliable picture of the climate, local variations in topography and soil do affect the spectrum. It is obvious that the water-relations of the soil are not entirely conditioned by such factors as precipitation, humidity, winds, but to a large extent, also, by the nature of the substratum itself.

As seen in the table, we have attempted a comparison of the spectra of the various plant associations but the numbers of species are so greatly reduced in this treatment that the values for the different forms tend to be misleading, and comparison between associations break down. If, for example, the two associations spruit-bank-valley bush, and Acacia bush are compared, the former is found to show a lower value for MM than the latter, whereas in actual fact it is but a single species, *Celtis rhamnifolia*, which is concerned in both.

(*h*) The Relationship of the Area to the Karroo.

As mentioned in the introduction, the Area bears resemblances to the Karroo. The description of its physical and vegetational features will, it is hoped, have made this clear to the reader who is familiar with the Karroo. Pole Evans (1920, 1929) aptly describes the latter as a country of dry river-beds, shallow soils and exposed rock surfaces. The vegetation is scanty and consists of isolated tufts of bunch-grasses, stunted bushes and shrublets and is dominated over large areas, in the western portion, by *Euphorbia mauritanica* and, in the central portion, chiefly by *Mesembryanthemum spinosum*. The small patches of stunted bush found in the Karroo are similar to those in the Area, which has approximately 60 species of plants in common with the Karroo, but differs from it, in having a greater grass population.

The occurrence of a Karroid type of vegetation well within a great grassveld region arouses interest ; it demonstrates the development of

a similar type of vegetation as a result of similar conditions, and raises the question of its origin. Bews' (1925) view of the evolution of the S. African flora would dispose of the possibility of the Area representing a surviving remnant of a greater Karroo which in earlier times extended much further north than it does to-day, while the presence of identical, characteristic species precludes the hypothesis of purely parallel evolution. It is interesting to note, however, that a species such as *Mesembryanthemum spinosum*, which is apparently unable to survive in grassveld, must have migrated a distance of over 100 miles across a barrier of grassveld in order to have become established in the Bloemfontein Area.

(*i*) The Flora of the Area.

The list of plants tabulated below is, in all probability, far from being complete, but it serves, nevertheless, as a fairly good working basis. The weed population of cultivated land is not included ; neither are the algal or fungal populations listed, as knowledge of these is very incomplete. Introduced weeds which have become naturalized are included and are marked with an asterisk. Specimens of the species listed are preserved in the University College Herbarium.

BRYOPHYTA.

HEPATICAE.

Anthoceros laevis. Linn.
Fossombronia pusilla. (L) Dum.
Fimbriaria marginata. Nees.
Grimaldia sp.
Plagiochasma rupestre. Steph.
Riccia limbata. Besch.
R. albomarginata. Besch.
R. Pottsiana. Sim.
Targionia hypophylla. Linn.
Trichostomum brachystomum.

MUSCI.

Bryum turbinatum. (Hedw.) Schw.
B. canariense. Schp.
B. stellipilum. C.M.
B. mundii. C.M.
Dicranella sub-compressa. Hampe.
Didymodon afer. C.M.
Entosthodon Bergianus. Br. and Sch.
E. ampliretis. C.M.
E. Rottleri. C.M.
Fabronia pilifera. Hornsch.
Fabronia sp.
Fissidens bryoides. L.
F. pycnophyllus. C.M.
Hymenostylium ceratodonteum. Broth.
Hyophila Zeyheri. Jacq.
Physcomitrium succulentum. W. and W.
Pseudoleskeopsis claviramea. Jaeg.
Ptychomitrium cucullatifolium. C.M.
Tortula pilifera. Hk.
T. atroviridis. Lindb.
Weisia calcarea. C.M.
W. hyophiloides. W. and B.

PTERIDOPHYTA.

Marsileaceae.

Marsilea macrocarpa var. capensis. Sim.

Polypodiaceae.

Ceterach cordatum. (Thb.) Des.
Cheilanthes hirta. S.W.
Notholaena Eckloniana. Kunzl. (resurrection fern).
Pellaea hastata. Pr. (oak-leaf fern).
Pellaea viridis. Prantl.

ANGIOSPERMAE.

DICOTYLEDONEAE.

Aizoaceae.

Chasmatophyllum musculinum. Schwantes.
Delosperma Pottsii. Bolus.
Hymenocyclus luteus. Schwantes.
Hypertelis verrucosus. Fenzl.
Mesembryanthemum scapigerum. Harv.
M. spinosum. Linn. (doringvygie).
Ruschia unidens Schwantes.
Trichodiadema barbatum. Schwantes.
Stomatium mustellinum. Schwantes. (kussingvygie).

Amarantaceae.

*Alternanthera echinata. Smith (kakiekweek).
*Amaranthus paniculatus. Linn. (kalkoenslurp).
*A. Thunbergii. Moq. (Cape pigweed, red devil, mistbredie).
*A. caudatus. Linn.
*A. Blitum. Linn.
Achyranthes aspera. Linn. (klits, haakensteek).

Anacardiaceae.

Rhus Burchellii. Sond.
R. ciliata. Licht. (kriebessie).
R. erosa. Thunb. (besembos, soettaaibos)
R. lancea, Lf. (kareeboom).
R. pyroides. Burch. (taaibos).

Apocynaceae.

Pachypodium succulentum. A.D.C. (dikvoet).

Araliaceae.

Cussonia paniculata. E. and Z. (cabbage tree, cork tree ; kiepersol, sambreel, nooiensboom).

Asclepiadaceae.

Asclepias multicaulis, Schltr. (melkbos, gansies).
A. fruticosa. Linn. (wilde kapok, tondel).
A. Burchellii. Schltr.
A. brevicuspis. Schltr.
A. gibba. Schltr.
A. Meyeriana. Schltr.
Caralluma lutea. N.E.Br.
Duvalia corderoyi. N.E.Br. (Hotnotstoontjie).
Sarcostemma viminale. R.Br. (melktou).
Stapelia flavirostris. N.E.Br. (carrion flower; bokhoring, aasblom).
S. gemmiflora. Mass. (carrion flower; bokhoring, aasblom).

Bignoniaceae.

Rhigozum obovatum. Burch. (driedoring).

Boraginaceae.

Anchusa capensis. Thb. (forget-me-not; ossetong).
Echinospermum lappula. Lehm.
Ehretia rigida (hottentotica). Burch. (Cape lilac).
Tournefortia tuberculosa. Cham.

Campanulaceae.

Cyphia triphylla. Phill.
Lightfootia albens. Spreng.
Lobelia Tysoni. Phillips.
Laurentia arabidea. A.D.C.
Parastranthus thermalis. Sond.
Wahlenbergia arenaria. A.D.C. (harebell).
W. nudicaulis. A.D.C.

Caryophyllaceae.

Dianthus scaber. Thb. (wild pink; wildeangelier).
Pollichia campestris. Ait. (kaffer-druiwe)
*Stellaria media. Cyrill. (chickweed; sterremuur).
Silene capensis. Benth.

Celastraceae.

Gymnosporia polyacantha. Szyszy.

Chenopodiaceae.

*Chenopodium ambrosioides. Linn. (stinking goosefoot, Mexican tea; stinkbossie).
*C. mucronatum. Thb.
*C. murale. Linn. (goosefoot; gansevoet)
Salsola foetida. Del.

Compositae.

Amphidoxa gnaphaloides. D.C.
Arctotis stoechadifolia. Berg. (bear's ears).
Artemisia afra. Jacq. (wormwood; wildeals).
Aster fruticulosus. Less.
A. filifolius. Vent. (draaibossie, gombossie).
A. muricatus. Less.
Bidens pilosa. Linn. (black-jack; wewenaars).
Cenia microglossa. D.C.
Chrysocoma peduncularis. D.C. (bitter karobos).
C. tenuifolia. Berg. (bitter-bossie).
Cineraria geraniifolia. D.C.
Conyza podocephala. D.C.
Cotula leptalea. D.C.
Dicoma anomala. Sond. (wurmbos).
Euryops multifidus. D.C. (resin-bush; geelmagriet, harpuisbos).
E. sulcatus. Harv. (resin-bush; geelmagriet, harpuisbos).
Eriocephalus spinescens. Burch. (silverbossie).
Felicia muricata var. fasciculata. E.Mey.
F. fascicularis. D.C. (skaapbossie).
Garuleum pinnatifidum. D.C.
Geigeria passerinoides. Harv. (vermeerbossie).
Gnaphalium luteoalbum. Linn. (cudweed; roerkruid).
Othonna pallens. D.C. (springbokbossie).
Helichrysum argyrosphaerum. D.C.
H. aureonitens. Sch. and Bep.
H. dregeanum. Sond. and Harv.
Ifloga paronychioides. D.C.
Kleinia longiflora. D.C.
K. radicans. D.C. (bokbos).
Lasiopogon lanatum. Cass.
Matricaria globifera. Fenzl. (stinkkruid).
Nidorella hirta. D.C.
Pentzia sphaerocephala. D.C.
P. virgata. Less. (goedkaro, skaapbos).
Senecio achillaefolia. D.C.
S. erosus. Lf.

S. glanduloso-pilosus. Volkens and Muschl.
S. laevigatus. Thb.
S. nudiusculus. D.C.
*Schkuhria bonariensis. Hook and Arn. (yellow tumble-weed; rolkakie, rolbossie).
Sonchus oleraceus. Linn. (sow-thistle; melkdissel, sydissel).
*Tagetes minuta. Linn. (Mexican marigold).
Tarchonanthus camphoratus. Linn. (sagewood; kamferhout).
T. minor. Less. (vaalbos).
Tripteris pachypteris. Harv.
Vernonia Kraussii. Sch. Bip.
Venidium microcephalum. D.C.
V. arctotoides. Less.
*Xanthium spinosum. Linn. (burweed; boetebossie).

Convolvulaceae.

Convolvulus ulosepalus. Hall.
Ipomoea argyreioides. Choisy.
I. crassipes. Hook.
I. oblongata. E.Mey.
I. quinquefolia. Hochst.

Crassulaceae.

Cotyledoa. decussata. Sims.
C. trigyna Burch.
Crassula empestris. E. and Z.
C. Cooperi var. robusta. Schon.
C. corallina. Thunb.
C. fruticulosa. Linn.
C. muscosa. Linn.
C. nodulosa. Schon.
C. platyphylla. Harv.
Kalanchoe paniculata. Harv.

Cruciferae.

Heliophila suavissima. Burch.
Nasturtium fluviatile. E.Mey.
Sisymbrium lyratum. Burm.

Dipsacaceae.

Scabiosa columbaria. Linn. (wild scabious, pincushion, rice-flower).

Ebenaceae.

Euclea lanceolata. E.Mey. (bosgwarrie).
E. ovata. Burch. (gwarrie).
Royena (pallens. Thunb.) decidua. Burch. (bloubos).
R. (hirsuta. Linn) microphylla. Burch. (kritikom).

Euphorbiaceae.

Cluytia pulchella. Linn.
Euphorbia aspericaulis. Pax.
E. basutica. Marl. (vingerpol).
E. caterviflora. N.E.Br.
*E. Helioscopia. Linn. (milkweed, spurge; melkgras).
E. mauritanica. Linn. (geel melkbos).
E. Rudolfi. N.E.Br.
Phyllanthus humilis. Pax.
P. maderaspatensis. Linn.

Gentianaceae.

Sebaea Conrathii. Schinz.
S. pentandra. E.Mey.

Geraniaceae.

Geranium incanum. Burm.
Monsonia biflora. D.C. (dysentery-herb; naaldebossie, vrouebossie).
Pelargonium fumarioides. L.Her.
P. reniforme. Ait. (roderabas).

Labiatae.

Salvia rugosa. Thunb. (dassiebos, jako t-jong).
S. runcinata. Linn.
S. clandestina. Linn.
Stachys hyssopoides. Burch.
Stachys spathulata. Burch.
Teucrium capense. Thunb. (paddaklou).

Leguminosae.

Acacia karroo. Hayne. (karodoring, soetdoring, witdoring, doringboom).
Dolichos gibbosus. Thb. (wilde-entjie).
Elephantorhiza Burchellii. Benth. (elandsboontjie).
Indigofera argyraea. E. and Z.
I. alternans, D.C.
I. cryptantha. Benth.
I. Zeyheri. Spreng. (leehout).
Lessertia annularis. Burch. (krimpsiektebos).
L. tenuifolia. E.Mey.
Listia heterophylla. E.Mey. (yellow clover, Cape hop).
Lotononis divaricata. Benth.

L. laxa. E. and Z.
Medicago denticulata. Willd. (klawergras, klitsklawer).
M. nigra. Willd. (bur-clover, little burweed).
*Melilotus parviflora, Desf. (melilot; stinkklawer).
Melolobium cernuum. E. and Z. (heuningbos).
M. candicans. E. and Z. (heuningbos).
Rhynchosia Totta. D.C.
Sutherlandia frutescens. R.Br. (cancerbush; kankerbos, eendjies, gansies).
Tephrosia lurida. Sond.
T. polystachya. E.Mey.
Trifolium africanum. Ser. (Cape clover).
*Vicia sativa. Linn.

Loganiaceae.

Chilianthus arboreus. Benth. (bastard olive; vaalbos, wildevlier).

Loranthaceae.

Viscum pauciflorum. Linn. (mistletoe; voëlent).

Lythraceae.

Lythrum hyssopifolium. Linn.

Malvaceae.

Abutilon Sonneratianum. Cor.
Hibiscus aethiopicus. Linn.
H. atromarginatus. E. and Z.
H. malacospermus. E.Mey.
H. pusillus. Thunb.
H. trionum. Linn. (Black-eyed Susan).
Sida cordifolia. Linn.

Martyniaceae.

*Martynia montevidensis. Cham. (mulegrab).

Nyctaginaceae.

Boerhaavia pentandra. Burch.

Oleaceae.

Menodora africana. Hook.
Olea verrucosa. Link. (wild olive; oleenhout, olyfboom, wilde-olyf, oliewenhout).

Oxalidaceae.

Oxalis corniculata. Linn. (sorrel; suuring, pypklawer.)

Papaveraceae.

*Argemone mexicana. Linn. (Mexican poppy; blouduiwel, steekbossie).
Papaver aculeatum, Thunb.
*Fumaria officinalis. Linn.

Pedaliaceae.

Pterodiscus speciosus. Hook.
Sesamum capense. Burm.

Phytolaccaceae.

Limeum linifolium. Fenzl.
L. viscosum. Fenzl.

Plantaginaceae.

Plantago dregeana. Pres.

Polygonaceae.

*Polygonum aviculare. Linn. (knotweed; duisendknoop, varkgras).
P. lapathifolium. Bolus.
Rumex Ecklonianus. Meisn. (dock).

Portulacaceae.

Anacampseros filamentosa. Sims. (hasieskos, moerplantjie).
A. telephiastrum. D.C.
A. ustulata. E.Mey.
Portulaca oleracea. Linn. (purslane; varkkos, postelein).

Primulaceae.

Anagallis arvensis. Linn. (scarlet pimpernel, poor man's weatherglass; rooimuur).

Ranunculaceae.

Clematis Thunbergii. Steud. (traveller's joy; klimop).
Ranunculus pubescens. Thunb. (buttercup; botterblom, kankerblaar).

Rhamnaceae.

Zizyphus mucronata. Willd. (wag-'n-bietjie, blinkblaar).

Rubiaceae.

Galium capense. Thunb.
Hedyotis stricta. Sond.
Nenax microphylla. E. and Mey.

Santalaceae.

Osyris compressa. A.D.C. (bark-bush, Cape sumach; bergbas, jakkalspruim).
Thesium confine. Sond. (teringbos).
T. racemosum. Bernh.

Saxifragaceae.

Vahlia capensis. Thunb.

Scrophulariaceae.

Diclis petiolaris. Benth.
Dischisma ciliatum. Choisy.
Limosella capensis. Linn.
L. aquatica. Linn. var. tenuifolia. Hook.
Manulea Benthamiana. Hiern.
M. androsacea. E.Mey.
Peliostomum leucorrhizum. E.Mey.
Selago albida. Choisy. (water-finder ; aarbossie).
Sutera aurantiaca. Hiern.
S. argentea. Hiern.
S. caerulea. Hiern.
S. crassicaulis. Hiern.
Veronica anagallis. Linn. (speedwell).
Zaluzianskya crocea. Schltr.

Solanaceae.

Lycium oxycladum. Miers.
L. Kraussii. Dunal.
Solanum incanum. Linn. (bitterappel).
S. nigrum. Linn. (deadly nightshade, black nightshade ; nagskade, nastergal).
S. panduraeforme. E.Mey.
S. supinum. Dunal.

Sterculiaceae.

Hermannia bryonaefolia. Burch.
H. comosa. Burch.
H. depressa. N.E.Br.
H. pallens. E. and Z.
H. Rehmannii. Szyszy.
Mahernia coccocarpa. E. and Z.

Thymelaeaceae.

Gnidia polycephala. M.M. (Januariebossie).

Tiliaceae.

Grewia occidentalis. Linn. (four-corners ; kruisbessie).

Ulmaceae.

Celtis rhamnifolia. Presl. (white stinkwood, Camdeboo stinkwood ; witstinkhout, Camdeboostinkhout).

Umbelliferae.

Heteromorpha arborescens. C. and S. (bergbas).

Urticaceae.

*Urtica dioica. Linn. (nettle ; brandnetel).

Verbenaceae.

Bouchea pinnatifida. Schauer.
Lantana salviaefolia. Jacq. (birds' brandy, num-num).
Lippia reptans. H.B. and K.
Verbena officinalis. Linn. (wild verbena ; verfyn).

Zygophyllaceae.

Tribulus terrestris. Linn. (dubbeltjie, dubbeldoring, volstruisdoring, duiweltjie).

MONOCOTYLEDONEAE.

Amaryllidaceae.

Ammocharis falcata. Herb.
Brunsvigia grandiflora. Lind.
Buphane toxicaria. Herb. (seeroogblom, gifbol, kopseer).
Haemanthus hirsutus, Bkr. (Bible plant).
Hypoxis angustifolia. Lam.
H. argentea. Harv. var. sericea. Bkr. (sterretjie).
Nerine sp. nr. lucida.

Commelinaceae.

Commelina africana. Linn.
C. karrooica. C.B. Clark.
C. bengalensis. Linn.

Cyperaceae.

Bulbostylis humilis. Kunth.
Cyperus difformis. Linn.
C. bellus. Kunth.
C. longus. Linn.
C. marginatus. Thunb.
C. usitatus. Burch. (uintjie, watergras).
Kyllinga alba. Nees.
Mariscus capensis. Schrad. (monkey bulb ; bobbejaansuintjie).
M. Rehmannianus, C.B.Cl.
Scirpus lacustris. Linn.
S. hystrix. Thunb.
S. Burkei. C.B.Cl.
S. nodosus. Rottb. (biesie).
S. paludicola, Kunth.
S. setaceus. Linn.

Gramineae.

Agrostis griquensis. Stapf.
Aristida angustata. Stapf. (steekgras).
A. Burkei. Stapf (steekgras).
A. barbicollis. Trin. and Rupr. (steekgras).
A. congesta. Roem and Schult. (steekgras).
Brachiaria Isachne. Stapf.
B. serrata. Stapf.
Briza minor. Linn.
Bromus unioloides H.B.K. (rescue grass).
Chloris virgata. Sw. (haygrass, sweetgrass; klossiesgras, wilde hawer).
Cymbopogon plurinodis. Stapf.
Cynodon dactylon. Pers. (couch, quickgrass; buffel-kweek, Batavisekweek).
C. incompletus. Nees (couchgrass; fynkweek).
Digitaria eriantha. Steud. (fingergrass; vingergras).
D. sanguinalis. (Linn.) Scop. (wild millet).
D. ternata (Hochst.) Stapf.
Diplachne fusca. Beauv.
Ehrharta erecta. Lam.
Eleusine indica. Gaertn. (goose-grass, crowfoot).
Enneapogon scoparius. Stapf.
E. brachystachyus. Stapf.
Eragrostis chloromelas. Steud.
E. curvula. Nees. (blousaad).
E. denudata. Hack (skaapgras).
E. gummiflua. Nees.
E. Lehmanniana. Nees. (soet blousaad)
E. major. Host
E. margaritacea. Stapf.
E. micrantha. Hack.
E. nebulosa. Stapf.
E. obtusa. Munro.
E. plana. Nees. ab. E (ospolgras).
E. procumbens. Nees.
E. superba. Peyr.
Eustachys paspaloides. L.M.
Heteropogon contortus. L.Beauv. (speargrass; steekgras).
Hemarthria fasciculata. Kunth.
Hyparrhenia hirta. Stapf.
Lepturella capensis. Stapf.
Lolium temulentum. Linn. (darnel; drabok).
Microchloa caffra. Nees.
Panicum deustum. Stapf.
P. minus var. planifolium Stapf.
Paspalum dilatatum. Poir (large waterseed; breedsaad).
Pennisetum sphacelatum (Nees) Dur. and Schinz.
Poa annua. Linn. (walkgrass).
Pogonarthria falcata. Rend.
Phalaris minor. Retz. (small canary grass).
Rhynchelytrum roseum. Stapf. and Hubb.
Schismus fasciculatus. Beauv. (haasgras).
Setaria aurea. A. Braun.
S. flabellata. Stapf.
S. imberbis. R. and S.
S. verticillata. Beauv. (klitsgras).
Sporobolus discosporus. Nees.
S. fimbriatus. Nees.
S. Ludwigii Hochst.
Themeda triandra. Forsk. (red grass; rooigras).
Tragus koelerioides. Asch.
T. racemosus. All.
Trichoneura grandiglumis. Rendl.
Triraphis andropogonoides. (Steud) Phill.
Urochloa helopus. Stapf.

Hydrocharitaceae.

Lagarosiphon muscoides. Harv. (pondweed, watergrass; barbelgras, watergras).

Iridaceae.

Gladiolus edulis. Burch. (small afrikander; klein aandblom, patrysuintjie).
Homeria aurantiaca. Sweet. (red tulp; rooitulp).
H. pallida. Baker.
Moraea polystachya. Ker. (bloutulp).
M. simulans. Baker.
M. tenuis. Ker.

Juncaceae.

Juncus exsertus. Buchen.
J. rupestris, Kunth. (rush; biesie).

Liliaceae.

Albuca sp. (undetermined).
Aloe grandidentata. Salm-Dyck. (aloe ; alwyn).
Androcymbium melanthioides. Willd. (men-in-a-boat ; patrysblom, bobejaanskoen).
Anthericum campestre. Moss.
A. paniculatum. Moss.
A. trichophyllum. Moss.
Asparagus africanus. Lam. (wag-'n-bietjie).
A. angolensis. Baker.
A. asiaticus. Linn. (katbos).
A. microrhaphis. Baker.
Asparagus sp. (undetermined).
Bulbine asphodeloides. R. and S. (wilde kapiwa, geel katstert).
B. narcissifolia. Salm-Dyck (slangkop).
Dipcadi gracillimum. Baker.
D. hyacinthoides. Baker (curly-curly, jig-a-jig).
Drimia angustifolia. Baker.
Eriospermum Bellendeni. Sweet.
Eucomis undulata. Baker. (wild pine-apple ; krulkop).
Hessea karooica. Barker.
Massonia Greenii. Baker.
Ornithogalum setifolium. Kunth.
O. spicatum. Baker.
Scilla lanceaefolia. Baker. (wild squill).
S. MacOwani. Baker.
S. rigidifolia. Kunth. (wild squill).
Symplegma pulchellum (Baker) Moss.
Tulbaghia acutiloba. Harv. (wild garlic).

Potamogetonaceae.

Potamogeton pusillum. Linn. (pond-weed ; fonteinkruid).

SECTION IV.

Summary.

Section I.

The site investigated is approximately 18 sq. miles in extent. It is situated to the north of the town of Bloemfontein and is composed of rocky koppies and bults separated by winding valleys through which wander dry spruits and sloots. The soils are mostly shallow and interspersed with exposed rock-surfaces. The Area gives the general impression of an island of scrub raised in a sea of grassveld. It is clothed mainly by short, open scrub in which are scattered small patches of bush and grassland

Section II.

(*a*) The climate is one of summer rains; it is characterised by droughts and great extremes of temperature. The summers are long and hot; hot desiccating winds are a feature. The winters are characterised by very low night temperatures accompanied by severe frost. Hail is frequent; snow is rare.

(*b*) The Area is composed of a doleritic boss overlying rock of the Beaufort Series. It has been weathered to form a network of valleys and dongas between which are the koppies and bults. The irregular and broken nature of the topography offers many and varied habitats to plants.

(*c*) The soils are mostly shallow; all are of doleritic origin, (1) sedentary, brown and gravelly, or (2) alluvial, dark-coloured and clayey. Those on bults, on north-east, north, and west slopes of koppies are of the first type; those in valleys and depressions are of the second type.

Section III.

(*a*) The vegetation is composed of three main types: scrub, bush and grassland. Scrub comprises the 5 associations; *Mesembryanthemum spinosum—Euphorbia mauritanica*; *Euryops sulcatus—Euphorbia mauritanica*; *Euryops sulcatus—Themeda triandra*; *koppie scrub*; and *Rhus ciliata—Themeda triandra.*

Bush includes 3: *koppie bush*; *spruit-bank-valley bush* and *Acacia bush.*

Pure grassland is composed of the single association, *valley grassland.*

Scrub occupies 92% of the total vegetation cover, bush 6% and grassland 2%.

(*b*) *Mesembryanthemum spinosum—Euphorbia mauritanica* inhabits the most rocky and shallow-soiled situations on bults and koppie summits.

Euryops sulcatus—Euphorbia mauritanica occupies somewhat deeper and less rocky soils on bults.

Euryops sulcatus—Themeda triandra finds its abode on still deeper soils, and is found both on brown soil on koppies and bults, and in dark alluvial soil in depressions.

Koppie scrub clothes the summits of koppies, and koppie-slopes facing north-east, north and west. The soil is shallow talus.

Rhus ciliata—Themeda triandra is an occupant of the lower slopes of koppies and outer edges of bults abutting on the surrounding grassveld, where a more uniform soil-cover is developed.

Koppie bush forms stands on the steep sides of koppies and valleys facing south and south-east, and along the sides of rocky dongas among the koppies. It invariably inhabits deep talus.

Spruit-bank-valley bush lines the banks of spruits and sloots in valleys, and forms scattered clumps on the floors of the latter. It is an occupant of deep alluvial soil.

Acacia bush inhabits deep alluvial soil where the spruits and sloots form flushes near the mouths of the valleys.

Valley grassland occupies relatively moist and deep soil along the sides of watercourses ; in small flushes where Acacia bush is not developed, and areas between the bush clumps in the valleys.

(*c*) The various communities probably represent, each in its own particular habitat, the highest form of vegetation which can develop there to-day, each being essentially in harmony with a relatively stable habitat.

(*d*) The factors concerned in the distribution of the associations are dealt with. Soil is the most important and is shown to be especially significant in the distribution of koppie bush.

(*e*) Two main paths of succession are traced : lithoseric and hydroseric. Of the lithoseric there are two types, moist and dry.

(*f*) Five flowering aspects are described : hibernal, prevernal, vernal, aestival and autumnal.

(*g*) Raunkiaer's spectrum method was applied. Life form spectra of the vegetation of the Area as a whole, and of each association are given, and for comparison, the normal spectrum also. The method was not very successful. The resemblances and relationships of the Area to the Karroo are discussed.

The importance of distinguishing between direct and indirect factors in ecological work is emphasised, and illustrated by the case of koppie bush.

REFERENCES.

1. Aitken, R. D. .. The Effect of Slope Exposure on the Climate of a Hill near Maritzburg. S.A. Journ. Sci. XIX, 207-17, Dec. 1922.

2. Bews, J. W. .. An Account of the Chief Types of Vegetation in South Africa, with Notes on the Plant Succession. Journ. Ecol. IV, 129-59, 1916.

3. Bews, J. W. .. The Grasses and Grasslands of South Africa. Pietermaritzburg, 1918.

4. Bews, J. W. .. Plant Forms, and their Evolution in South Africa. London, 1925.

5. Evans, I. B. Pole The Plant Geography of South Africa. Union Official Year Book, 3, 48-55, Pretoria 1920.

6. Evans, I. B. Pole The Vegetation of South Africa. S.A. and Sci. 192-214, Johannesburg, 1929.

7. Galpin, E. E. .. Botanical Survey of the Springbok Flats. Bot. Surv. S.A. 12, 1926.

8. Phillips, J. F. V. Some Important Vegetation Communities in the Central Province of Tanganyika Territory. Journ. Ecol. XVIII, 2, 193-234, 1930.

9. Potts, G. . . .. The Pepper Tree (*Schinus molle*) as a Cause of Hay Fever in S. Africa. South African Journal of Science XIX, 1922.

10. Raunkiaer, C. .. The Life Forms of Plants, and Plant Geography. Oxford, 1934.

11. Weaver, J. E., and Clements, F. E. Plant Ecology. New York and London, 1929.

MESEMBRYANTHEMUM SPINOSUM—EUPHORBIA MAURITANICA

Belt Transect showing the size and spacing of the plants.

Scale : 1 inch = 6 feet.

Reference

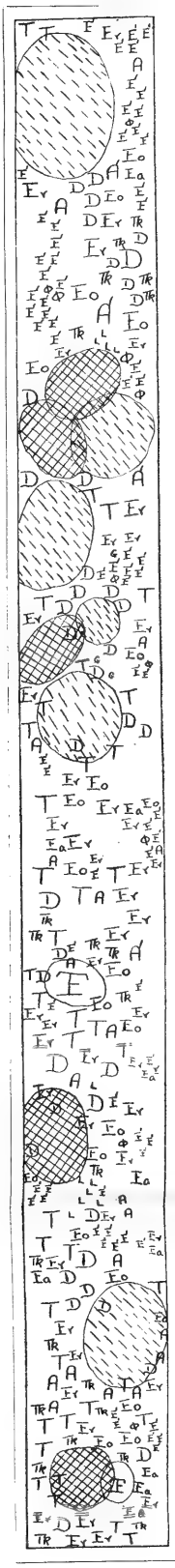
		Height
Individuals		
	Euphorbia mauritanica L	1¼-2½'
	Euryops sulcatus Harv	1-1½'
	Mesembryanthemum spinosum L	1-2¼'
Groups		
	Kleinia radicans D.C.	1-4½"
	Sarcostemma viminale R.Br.	6-12"
	Close stands of Eragrostis denudata Hack.	3-5½"
A	Aristida congesta Roem & Schult.	6-9"
Á	Aristida Burkei Stapf.	1½-2'
Á	Aristida angustata Stapf.	5-12"
Ar	Aristida barbicollis Trin & Rupr.	6-9"
At	Anthericum paniculatum Moss.	± 18"
Cf	Crassula fruticulosa L	1½-3"
D	Digitaria eriantha Steud.	1½-2¼'
Ea	Eragrostis sp. nr. Atherstonei	6-8"
E	Eragrostis denudata Hack.	3-5½"
Eb	Euphorbia mauritanica L.	14-18"
Eu	Eustachys paspaloides L M.	1¼-2'
F	Eriocephalus spinescens Burch.	6-8"
G	Geigeria passerinoides Harv.	1½-2½"
H	Heliophila suavissima Burch	±18"
L	Lepturella capensis Stapf.	1½-2½"
M	Mesembryanthemum spinosum L.	8-10"
Ø	Mariscus capensis Schrad.	2-4"
S	Sutera coerulea Hiern.	±7"
Sp	Stapelia flavirostris N.E.Br.	±6½"
T	Themeda triandra Forsk.	1½-2'
Tk	Tragus koelerioides Asch	3-7"

The blank areas represent bare rock surfaces.

Fig. II EURYOPS SULCATUS—EUPHORBIA MAURITANICA

Belt Transect showing the size and spacing of the plants.

Scale : 1 inch = 3 feet.



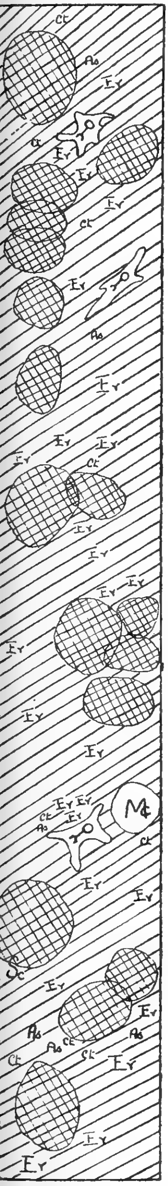
Reference

Individuals	Height
Euphorbia mauritanica L.	1¼ - 2¼'
Euryops sulcatus Harv.	1 - 2¼'
A : Aristida congesta Roem & Schult :	7 - 10"
Á : Aristida Burkei Stapf.	1½ - 2'
D : Digitaria eriantha Steud.	1½ - 2½'
Ea : Eragrostis sp. nr. Atherstonei.	6 - 9"
E : Eragrostis denudata Hack.	3½ - 6"
Eo : Eragrostis obtusa Munro.	6 - 10"
Er : Eragrostis Lehmanniana Nees.	9 - 12"
F : Eriocephalus spinescens Burch.	6 - 8"
L : Leptochloa capensis Stapf.	1½ - 2½"
Φ : Mariscus capensis Schrad.	2 - 4"
T : Themeda triandra Forsk.	1½ - 2¼'
Tk : Tragus koelerioides Asch.	3 - 7"
G : Geigeria passerinoides Harv.	1½ - 2½"

EURYOPS SULCATUS—THEMEDA TRIANDRA.

Belt Transect showing the size and spacing of the plants.

Scale : 1 inch = 6 feet.



Reference

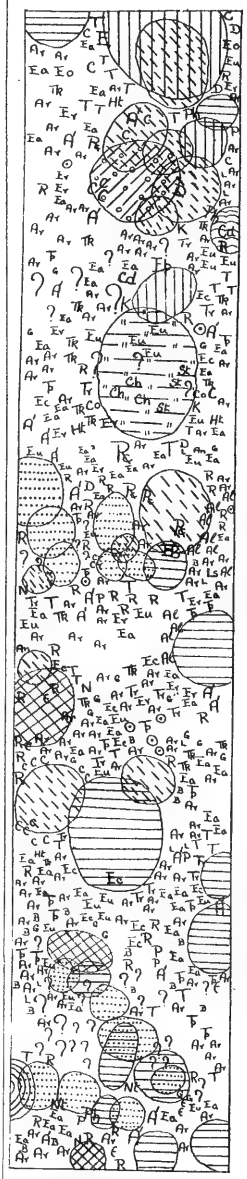
Individuals		Height
Cross Hatch	Euryops sulcatus Harv.	$1\frac{1}{4}$ – $2\frac{1}{2}$′
As	Aster sp.	5 – 7″
Ct	Chrysocoma tenuifolia Berg.	$6\frac{1}{2}$ – 9″
♀	Convolvulus ulosepalus Hall.	¾ – 1″
Er	Eragrostis Lehmanniana Nees.	18″ – 2′
Mt	Melolobium candicans E & Z.	± 9″
Sc	Scabiosa columbaria L.	8 – 14″
Left Hatch	Close stand of Themeda triandra Forsk.	$1\frac{1}{2}$ – $2\frac{3}{4}$′

Fig. IV

KOPPIE SCRUB.

Belt Transect showing the size and spacing of the plants.

Scale: 1 inch = 6 feet



Reference

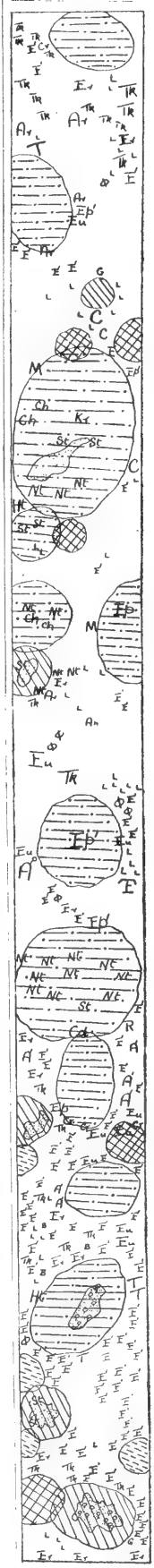
	Individuals	Height
	Euclea ovata Burch.	2½-3½'
	Ehretia hottentotica Burch.	±4½'
	Euphorbia mauritanica L.	1½-2½'
	Euryops multifidus D.C.	2½-3½'
	Euryops sulcatus Harv.	1½-2½'
	Olea verrucosa Link.	3-3½'
	Rhus Burchelli Sond	±5'
	Rhus ciliata Licht.	3½-4'
	Royena microphylla Burch.	±1½'
A	Aristida Burkei Stapf.	1½-2'.
Al	Aloe grandidentata Salm Dyck	12-14"
An	Anacampseros telphiastrum D.C	±3"
Ar	Aristida barbicollis Trin & Rupr.	8-11".
B	Bulbostylis humilis Kunth.	1½-2"
C	Cymbopogon plurinodis Stapf.	2-2½'
Cd	Cotyledon decussata Sims.	±8"
Ch	Cheilanthes hirta Sw.	5-8"
Co	Commelina karrooica C.B. Clark.	
Cr	Crassula platyphylla Harv	4-6"
D	Digitaria eriantha Steud.	1½-2½'
E	Euryops sulcatus Harv	±12"
Ea	Eragrostis sp. nr. Atherstonei.	6-9"
Eb	Elephantorrhiza Burchellii Benth.	±8"
Ec	Eragrostis curvula Nees	1½-2½'
Ep	Euphorbia mauritanica L.	±18"
Er	Eragrostis Lehmanniana Nees	8-12"
Eu	Eustachys paspaloides L M.	1¼-2'
⊙	Eneapogon scoparius Stapf.	9-12"
€	Euryops multifidus D.C.	6-12"
?	Euclea ovata Burch.	9-15"
G	Geigeria passerinoides Harv.	1½-3"
Ht	Heteropogon contortis R & S	1-1¼'
K	Kalanchoe paniculata Harv	2-2¼'
L	Leptureella capensis Stapf.	1½-2½"
Ls	Lantana salviaefolia Jacq	±14"
N	Nenax microphylla E & Mey.	6-8"
Nt	Notholaena Eckloniana Kunzl.	6-8"
P	Phyllanthus maderaspatensis L.	6-10"
Ph	Pellaea hastata Pr.	6-11"
R	Rhynchelytrum roseum Stapf & Hubb	12-14"
Rc	Rhus ciliata Licht	1-2½'
St	Sarcostemma viminale R.Br.	5-9"
T	Themeda triandra Forsk.	1½-2¼'
Th	Tragus koelerioides Asch.	3-7"
Tr	Triraphis andropogonoides (Steud) Phill.	2-2½'
Tr	Trichoneura grandiglumis Rend.	7-10"
Eo	Eragrostis obtusa Munro.	6-10"

Fig. IVa.

KOPPIE SCRUB.

Belt Transect through an open stand of Rhigozum obovatum showing the size and spacing of the plants.

Scale : 1 inch=4 feet.



Reference

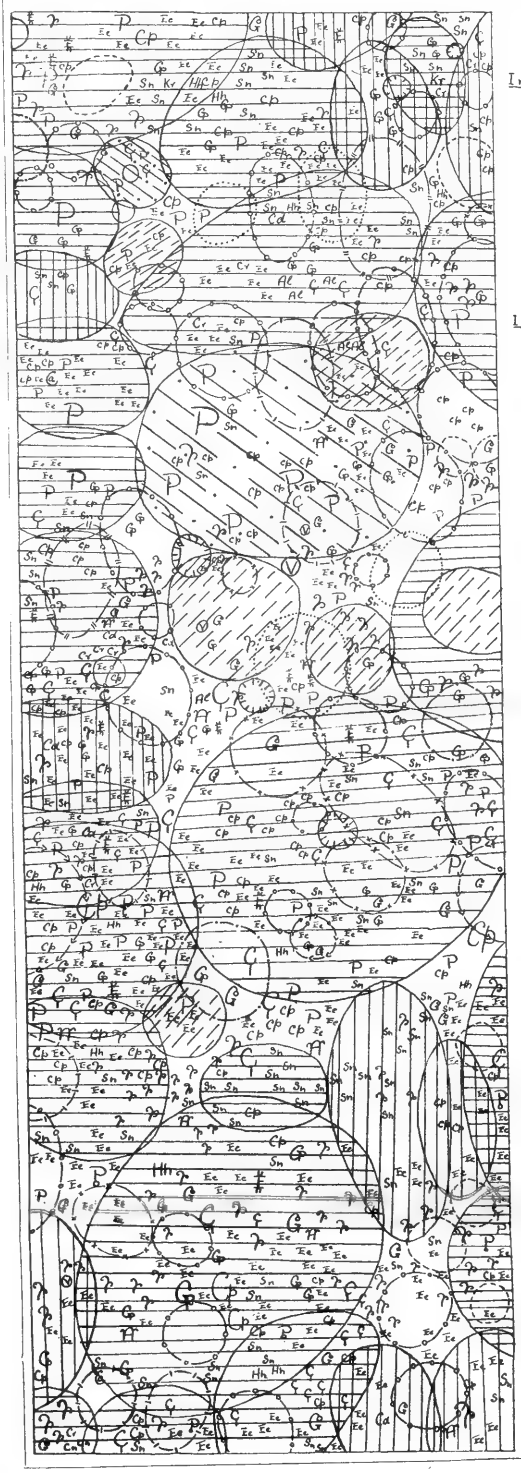
Individuals		Height
	Euphorbia mauritanica L	1-2'
	Euryops multifidus D.C	1½-2½'
	Kleinia radicans D.C.	1-4½"
	Mesembryanthemum spinosum L	1-2¼'
	Rhigozum obovatum Burch.	3½-9'
	Sarcostemma viminale R.Br	3-7"
A	Aristida Burkei Stapf.	1½-2'
A	Aristida angustata Stapf.	±12"
Ar	Aristida barbicollis Trin. & Rupr.	6-12"
An	Anacampseros telphiastrum D.C.	±3"
B	Bulbostylis humilis Kunth.	1-2½"
C	Cymbopogon plurinodis Stapf.	2-2½'
Cd	Cotyledon decussata Sims.	±7"
Ch	Cheilanthes hirta Sw.	5-8"
Cr	Crassula platyphylla Harv.	4-6"
E	Eragrostis denudata Hack.	3-5"
Ep	Euphorbia mauritanica L.	±18"
Ep'	Euphorbia caterviflora N.E.Br	8-10"
Er	Eragrostis Lehmanniana Nees	7-9"
Eu	Eustachys paspaloides L.M	1¼-2'
E	Eriocephalus spinescens Burch	±7"
G	Geigeria passerinoides Harv	1½-2½"
Ht	Heteropogon contortus R&S.	1-1¼'
Kr	Kleinia radicans D.C	1-4½"
L	Lepturella capensis Stapf.	1½-2½"
M	Mesembryanthemum spinosum L	5-8"
Ø	Mariscus capensis Schrad	2-4"
R	Rhynchelytrum roseum Stapf & Hubb	±12"
St	Sarcostemma viminale R.Br.	3-5"
T	Themeda triandra Forsk	1½-2'
Tk	Tragus koelerioides Asch.	3-6"
Nt	Notholaena Eckloniana Kunzl.	6-8"

Fig. V

KOPPIE BUSH.

Belt Transect showing three discontinuous layers of vegetation and the size and spacing of the individual plants.

Scale : 1 inch = 6 feet.



Reference

1st (Upper) Layer — Height : 12-16'

Individual Crowns

- Chilianthus arboreus Benth.
- Cussonia paniculata E.&Z.
- Grewia occidentalis L.
- Olea verrucosa Link.

2nd Layer — Height : 3½-6½'

Individual Crowns

- Cluytia pulchella L.
- Chilianthus arboreus Benth.
- Cussonia paniculata E.&Z.
- Ehretia hottentotica Burch.
- Euclea lanceolata E.&Mey.
- Grewia occidentalis L.
- Gymnosporia polycantha Szyszy.
- Heteromorpha arborescens C.&S.
- Olea verrucosa Link.

3rd Layer — Height below 3½'

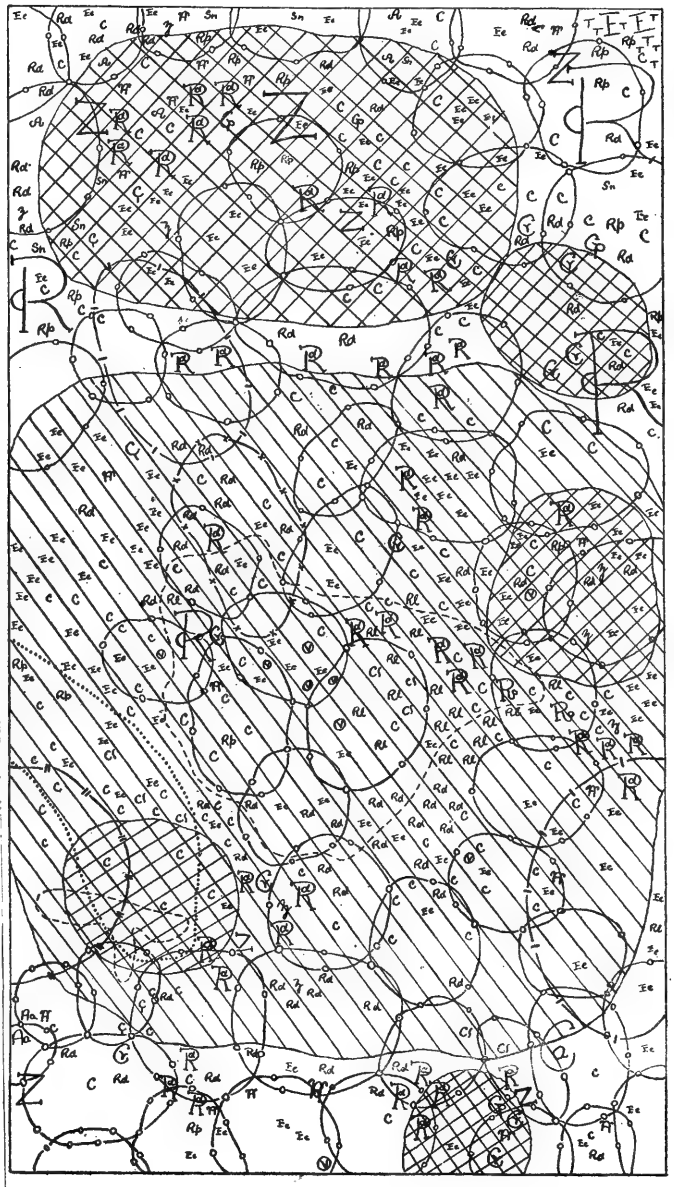
- Asparagus sp. prob. microrhaphis Baker.
- Al Aloe grandidentata Salm Dyck.
- Ca Chilianthus arboreus Benth.
- Cd Cotyledon decussata Sims.
- Cn Crassula nodulosa Schön.
- Cp Cluytia pulchella L.
- Cr Crassula platyphylla Harv
- Ç Cussonia paniculata E.&Z.
- Ee Ehrharta erecta Lam.
- Euclea lanceolata E.&Mey.
- Eucomis undulata Ait
- G Grewia occidentalis L.
- Gp Gymnosporia polycantha Szyszy.
- Hh Haemanthus hirsutus Baker.
- Kr Kleinia radicans D.C.
- Olea verrucosa Link.
- P Panicum deustum Thunb.
- Sn Solanum nigrum L.

Fig VI.

SPRUIT-BANK-VALLEY-BUSH.

Belt Transect showing four discontinous layers of vegetation and size and spacing of the individual plants.

Scale : 1 inch = 8 feet



Reference

1st (Upper) Layer Height: 15-18'

- Celtis rhamnifolia Presl. (individual crowns)
- Rhus lancea L.f. (individual crown)

Crown — 2nd Layer Height 8-12'

- Gymnosporia polycantha Szyszy.
- Olea verrucosa Link.
- Clematis Thunbergii Steud.
- Rhus pyroides Burch.
- Royena decidua Burch.
- Zizyphus mucronata Willd.

3rd Layer Height 4-6'

- C — Celtis rhamnifolia Presl.
- Ch — Chilianthus arboreus Benth.
- Gp — Gymnosporia polycantha Szyszy.
- Rp — Rhus lancea L.f.
- R — Royena decidua Burch.
- Z — Zizyphus mucronata Willd.

* 4th Layer Height: below 4'

- A — Achyranthes aspera L.
- Aa — Artemisia afra Jacq.
- M — Asparagus sp. prob. africanus Lam.
- C — Celtis rhamnifolia Presl.
- Ca — Chilianthus arboreus Benth.
- Cl — Clematis Thunbergii Steud.
- Ct — Chrysocoma tenuifolia Berg.
- Cy — Cussonia paniculata E & Z.
- E — Euryops sulcatus Harv.
- Ee — Ehrharta erecta Lam.
- O — Olea verrucosa Link.
- Rd — Royena decidua Burch.
- Rl — Rhus lancea L.f.
- Rp — Rhus pyroides Burch.
- Sn — Solanum nigrum L.
- T — Themeda triandra Forsk.
- Z — Zizyphus mucronata Willd.

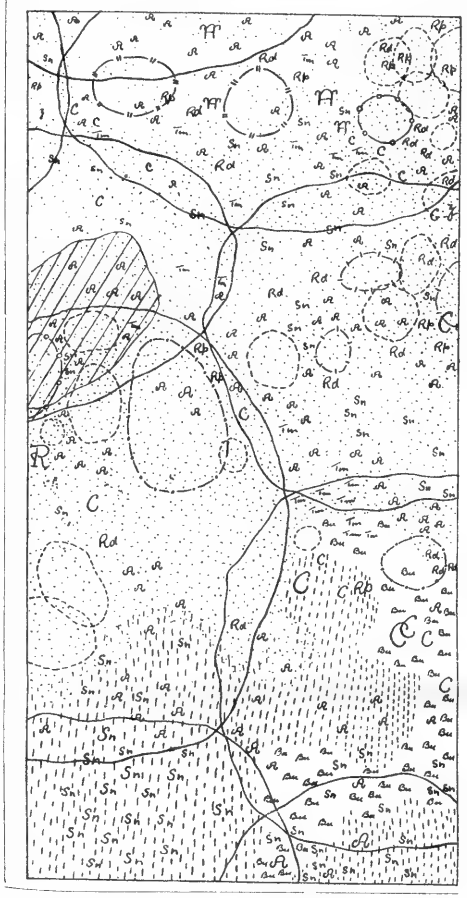
* R — Rhus pyroides Burch (Height 4-6')

Fig. VII

ACACIA BUSH.

Belt Transect showing the crowns of the dominant trees and the subordinate vegetation.

Scale : 1 inch = 10 feet



Reference

Simple Outline : Crowns of Acacia karroo Hayne. Height: 15-18'

Crown of Royena decidua Burch. Height: ± 12'

Acacia karroo Hayne.

Celtis rhamnifolia Presl.

Rhus lancea L.f.

Rhus pyroides Burch.

Zizyphus mucronata Willd.

Rhus pyroides Burch.

} Height 4-8'

Close stand of Bromus unioloides H.B.K. Height 6-9"

" " " Ihrharta erecta Lam " ± 6"

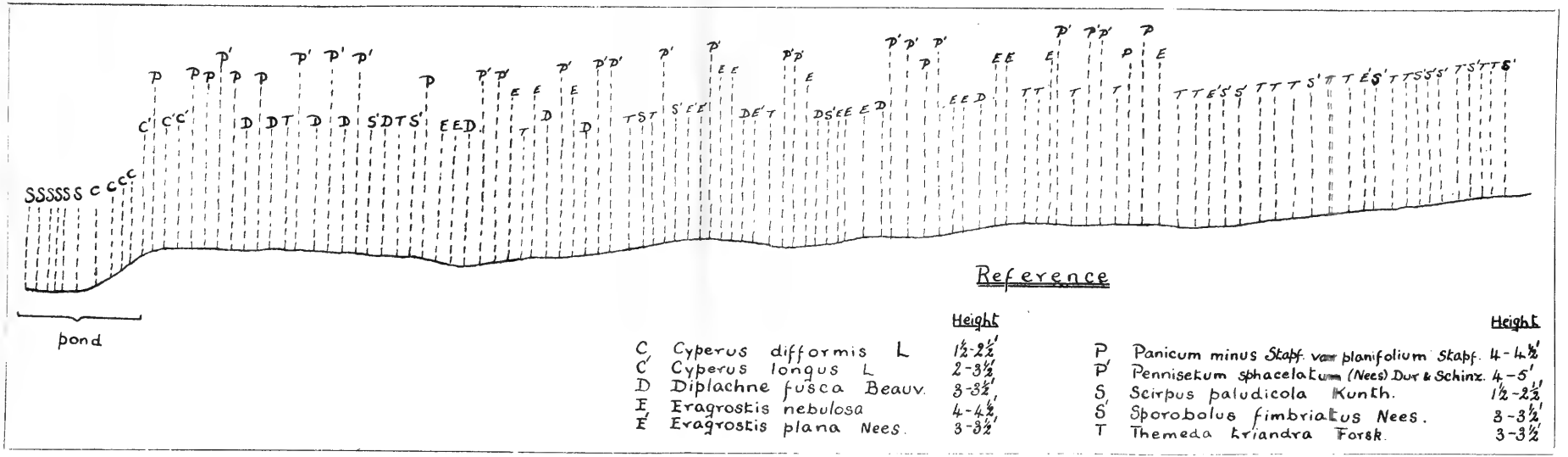
A	Achyranthes aspera L.	" 9-18"
Asp	Asparagus sp. prob. africanus Lam	" 2½-3½'
Bu	Bromus unioloides H.B.K.	" 6-9"
C	Celtis rhamnifolia Presl.	" 14"-3½'
Rd	Royena decidua Burch.	" 1-3½'
Rp	Rhus pyroides Burch.	" 1-3½'
Sn	Solanum nigrum L.	" 6"-18"
Tm	Tagetes minuta L.	" 2-3'
Z	Zizyphus mucronata Willd.	" 1½-3'

Fig. VIII

VALLEY GRASSLAND.

Line Transect through a small flush showing zonation.

Scale : 1 inch = 3 feet.

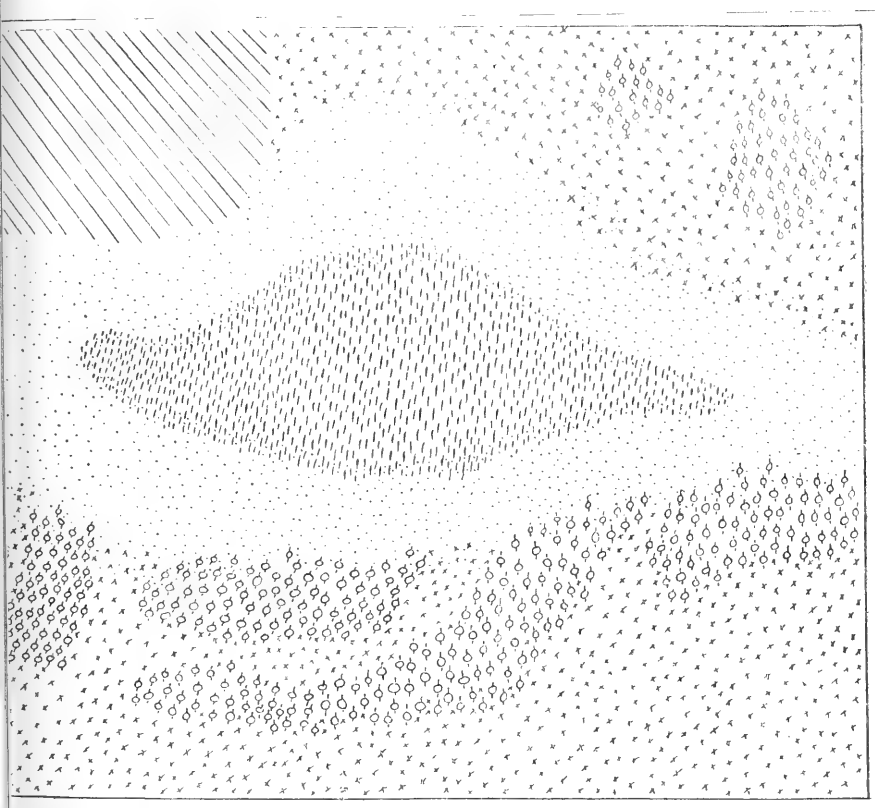


		Height
C	Cyperus difformis L	1½-2½′
C′	Cyperus longus L	2-3½′
D	Diplachne fusca Beauv.	3-3½′
E	Eragrostis nebulosa	4-4½′
E′	Eragrostis plana Nees.	3-3½′
P	Panicum minus Stapf. var planifolium Stapf.	4-4½′
P′	Pennisetum sphacelatum (Nees) Dur & Schinz.	4-5′
S	Scirpus paludicola Kunth.	1½-2½′
S′	Sporobolus fimbriatus Nees.	3-3½′
T	Themeda triandra Forsk.	3-3½′

VALLEY GRASSLAND.

Chart of a Small Flush showing Zonation of the Grasses.

Scale : 1 inch = 20 feet.



Eragrostis nebulosa with scattered Panicum minus Stapf. var. planifolium Stapf.

Pennisetum sphacelatum (Nees) Dunn & Schinz. with scattered Panicum minus Stapf var planifolium Stapf

Themeda triandra Forsk

Sporobolus fimbriatus Nees.

Acacia bush.

Fig. X

LINE TRANSECT THROUGH A VALLEY.

Showing the Difference in Vegetation of the Opposite Slopes facing North and South.

Scale : 1 inch = 40 feet.

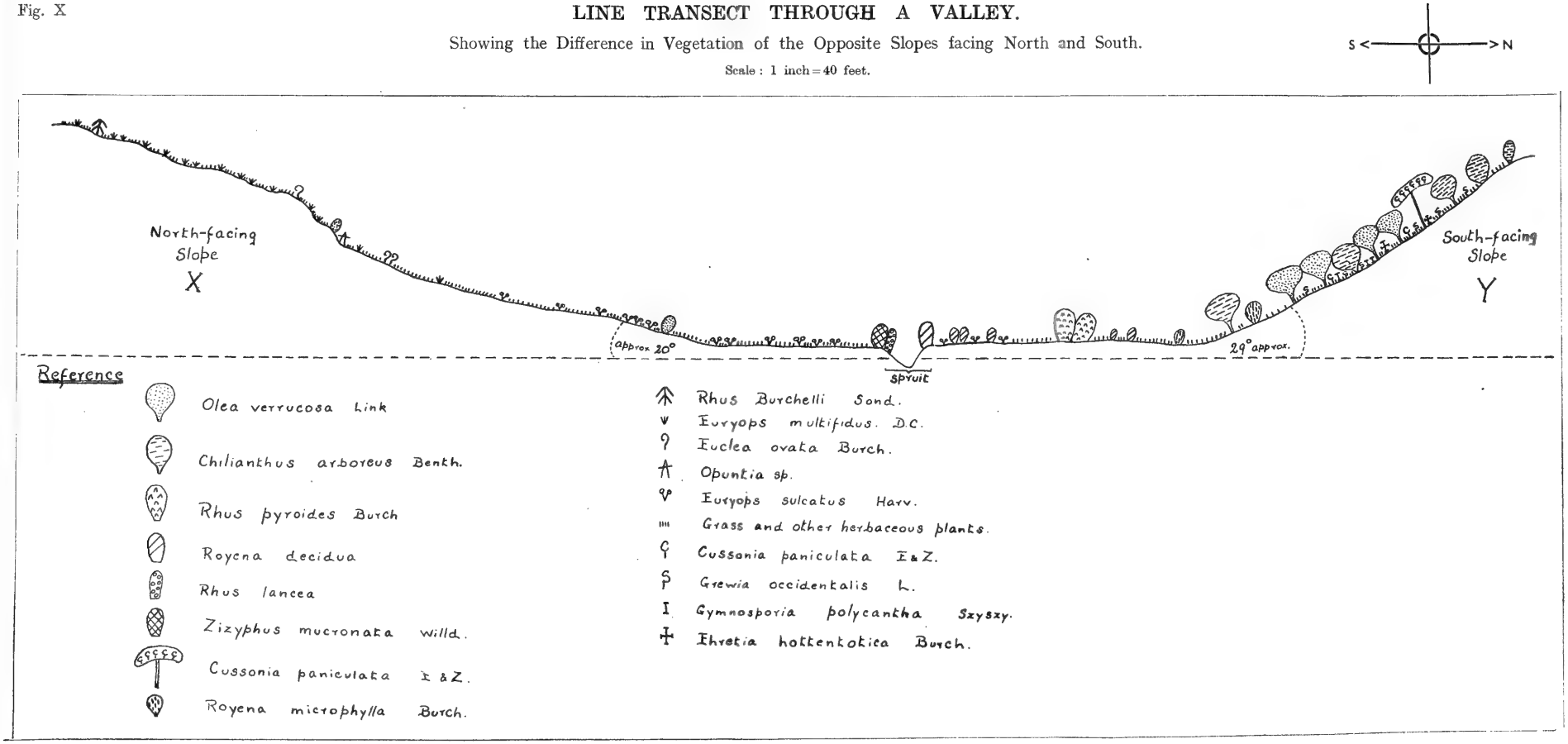


Fig. XI

Comparison of the evaporation, at 8″ above the soil surface, on the two slopes X,Y, Fig. X, January, 1935.

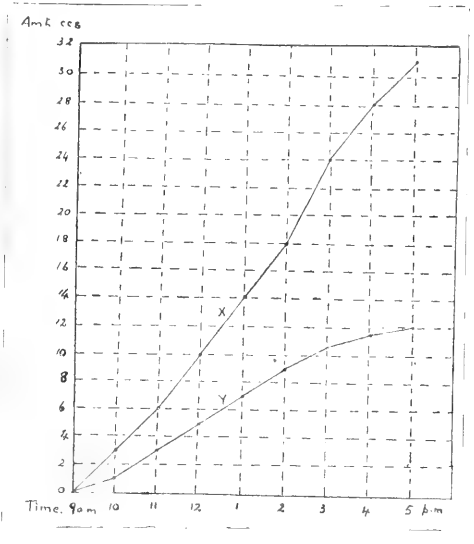


Fig. XII

Comparison of the rates of evaporation, in ccs. per hr., on the two slopes X,Y, Fig. X January, 1935.

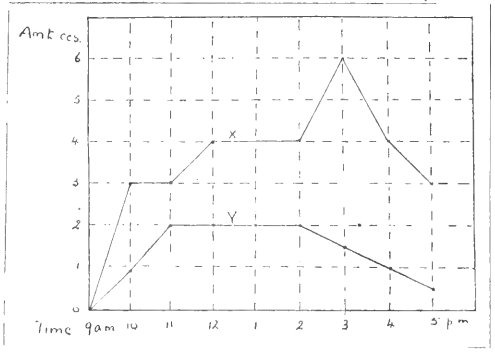


Fig. XIII

Comparison of the ranges of air temperature, at 36″ above the soil surface, on the two slopes X, Y, Fig. X.

January 1935.

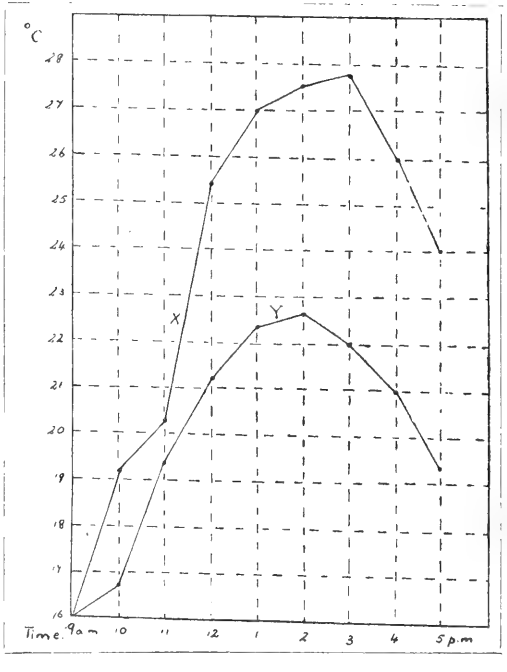


Fig. XIV

Comparison of the ranges of soil temperature at depth of 3″, on the two slopes X, Y, Fig X

January 1935.

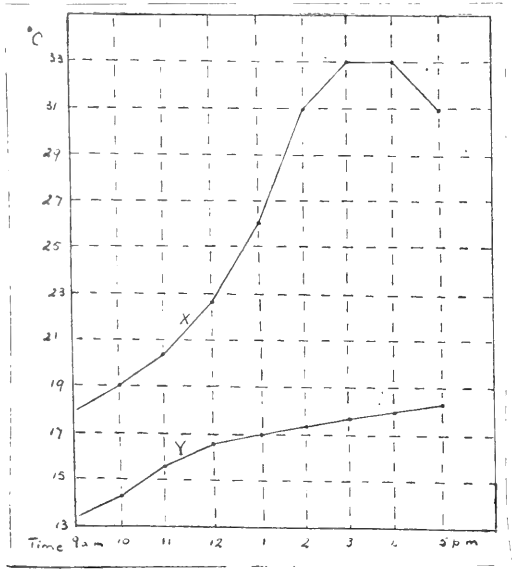


Fig. XV

Comparison of the ranges of relative humidity, at 36″ above the soil surface, on the two slopes X,Y, Fig. X January, 1935.

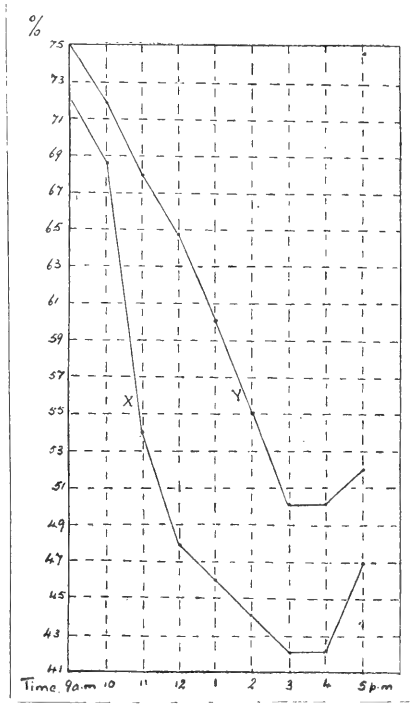


Fig. XVI

Comparison of the ranges of soil temperature, at depth of 3″, on the two slopes X,Y, Fig X. July, 1935

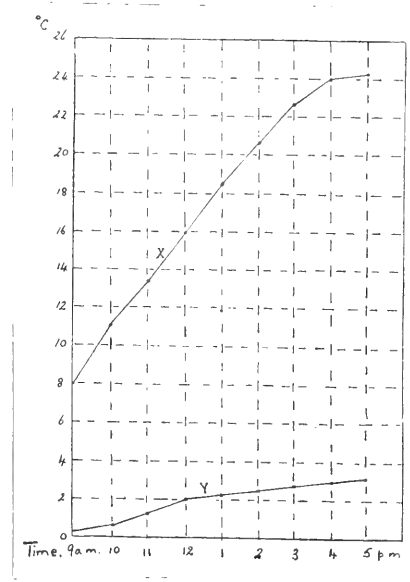


PLATE 6A. View of portion of the Area, showing valleys between the koppies. Note the bush clothing the southern faces of the koppies (koppie bush). The bush in the valleys is of a different type (spruit-bank-valley bush). Note the park-like appearance. The small trees in the foreground are *Olea verrucosa* and *Chilianthus arboreus*. The clumps in the valleys are composed of *Rhus lancea*, *R. pyroides*, *Royena decidua*, *Zizyphus mucronata*, *Celtis rhamnifolia*, and *Olea verrucosa*.

PLATE 6B. Heavily eroded koppie slope (facing west). Centre foreground: *Euphorbia mauritanica*. Left foreground: Several individuals of *Euryops multifidus*. Right foreground: Grasses, *Aristida spp.*, *Eragrostis denudata*, *Tragus koelerioides*, and mixed with them, the succulents, *Ruschia unidens*, and *Stomatium mustellinum*. Background: Groups of *Aloe grandidentata*, individuals of *Euryops multifidus*, *Euphorbia mauritanica*, and a mixture of the grasses cited above.

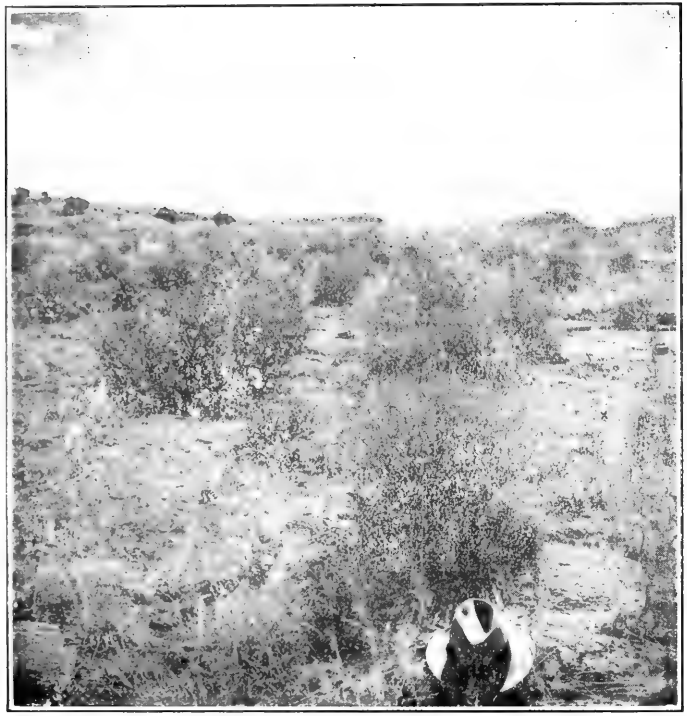


PLATE 7A. *Mesembryanthemum spinosum—Euphorbia mauritanica.* The grass in the foreground is mainly *Aristida Burkei.* The stone, left foreground, marks the proximal end of one chain of the belt transect, Fig. I ; the chain can be seen stretching back among the plants. Portion of the other chain can be seen to the right stretched between the two crosses marked in ink. Immediately behind the hat is an individual *Euphorbia mauritanica,* and projecting above the latter are a number of inflorescences of *Aristida Burkei.* Further back, centre, is a small individual of *Mesembryanthemum spinosum,* and behind it is seen a group of plants : *M. spinosum, E. mauritanica,* and *Aristida Burkei.* The patches of short grass alongside the left chain are composed chiefly of *Eragrostis denudata* with *Tragus koelerioides.*

PLATE 7B. Stage in the lithoseric succession. In the gravel areas between the rock outcrops are seen several cushions of *Stomatium mustellinum.* To the right are a number of small tufts of *Lepturella capensis.* The match-box affords an idea of size.

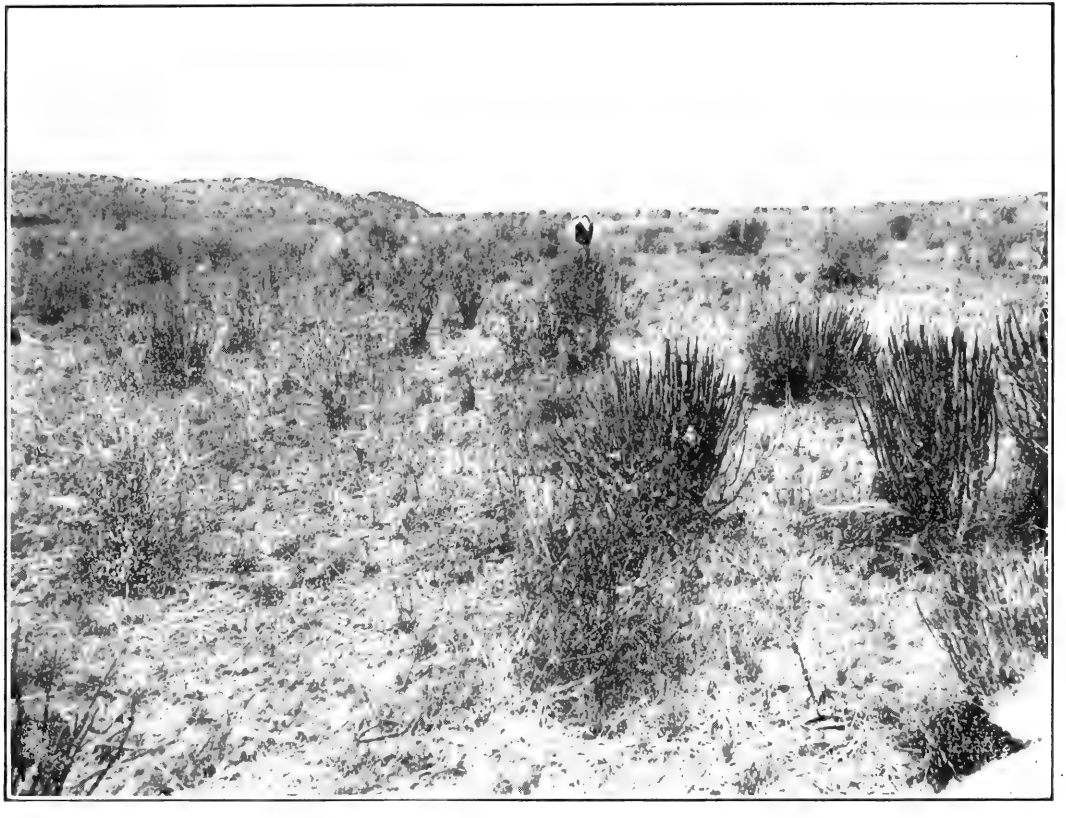


PLATE 8. *Euryops sulcatus—Euphorbia mauritanica.* In the foreground are seen the handles, and portions of the two chains of the belt transect, Fig. II. Between the chains in the foreground is seen a *Euryops sulcatus*, and behind it *Euphorbia mauritanica*. To the right are several plants of *E. mauritanica*, and to the left *Euryops sulcatus*. Note the uniform soil-cover, and the large grass population. The names of the grasses are given with Fig. II. The hat marks the distal end of the transect.

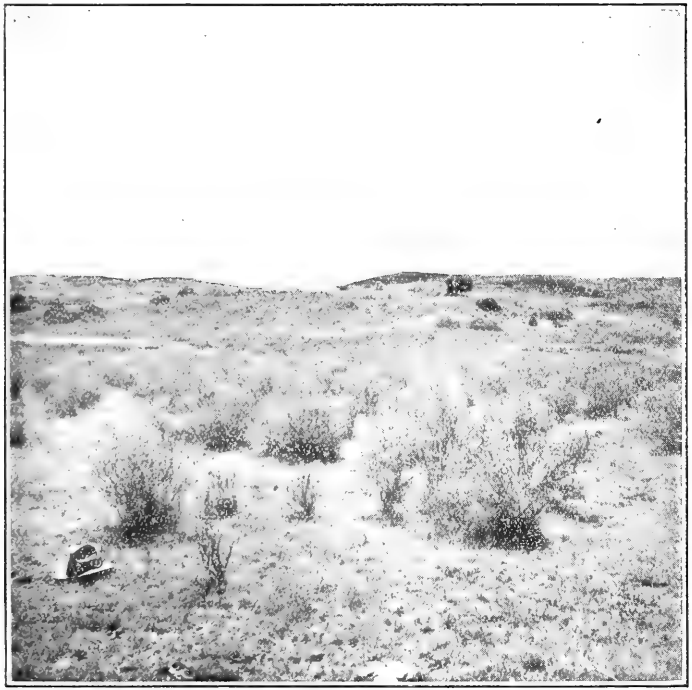


PLATE 9A. Well-watered, low-lying area with deep soil in which is a well-developed community of *Eurygops sulcatus* in a heavily-cropped Themeda-other-species grassland. Along the base of the bult in the background is faintly seen a grass-lined watercourse. The trees in the background are *Olea verrucosa*, and the scrub on the bult, *E. sulcatus*.

PLATE 9B. *Rhus ciliata—Themeda triandra*. The grasses are a mixture of *Themeda triandra*, *Eragrostis spp.*, and *Aristida spp.* The shrub clumps are groups of *Rhus ciliata*. From the hat, placed on a walking-stick, an idea of the heights of the plants is obtained.

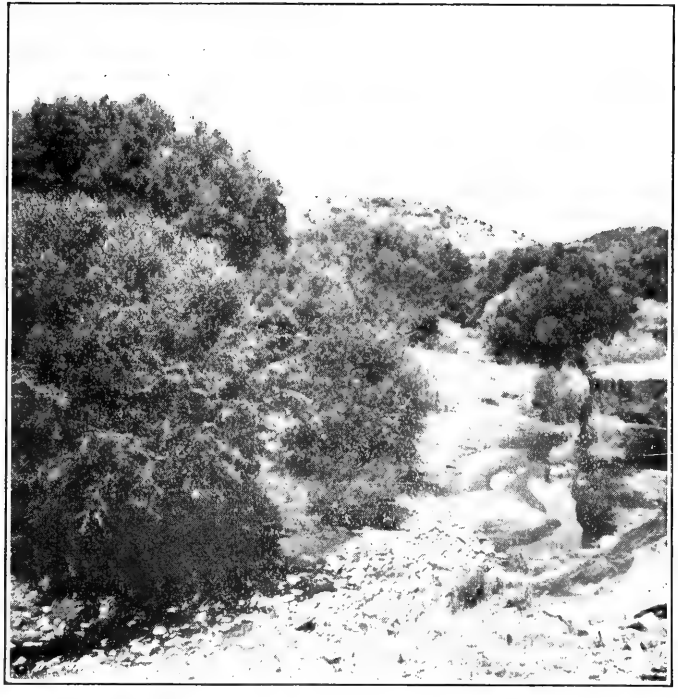


PLATE 10A. Spruit-bank-valley bush lining the banks of a spruit. Left bank: *Olea verrucosa* with *Zizyphus mucronata* projecting from its right margin. The large tree immediately behind is *Rhus lancea*, shown in Fig. VI. To the right of it is a small *Z. mucronata*, behind which is seen *Royena decidua*, and in front, a small individual of *Royena microphylla*. Right bank: Clumps of *Royena decidua*, *Rhus pyroides*, *Zizyphus mucronata*, *Rhus lancea*, and *Celtis rhamnifolia*.

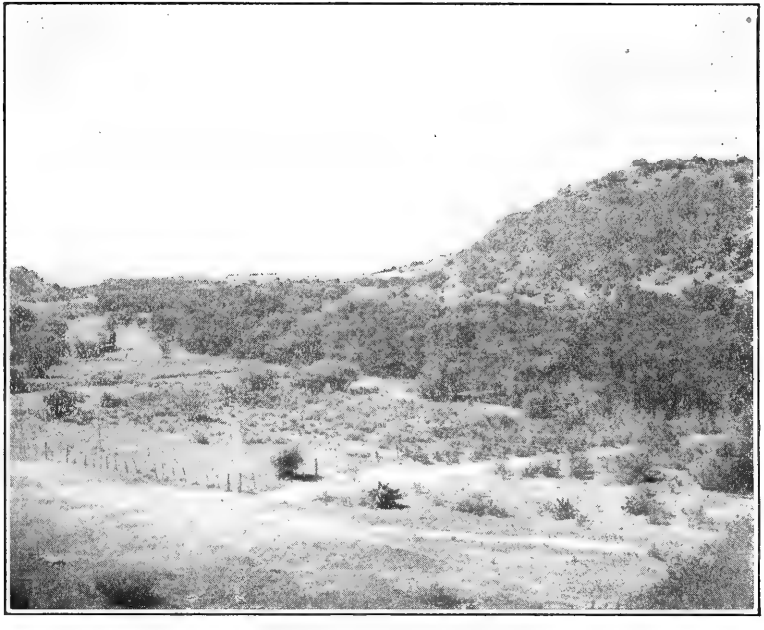


PLATE 10B. Acacia bush. (Tredenham, Map I.) The scrub in the paddocks is composed of *Rhus ciliata*, *Euryops sulcatus*, young clumps of spruit-bank-valley bush, and *Opuntia spp.* Behind is seen a line of Acacia bush following a flush into the grassveld. To the left, clumps of spruit-bank-valley bush, and in the right background a koppie clothed by koppie bush.

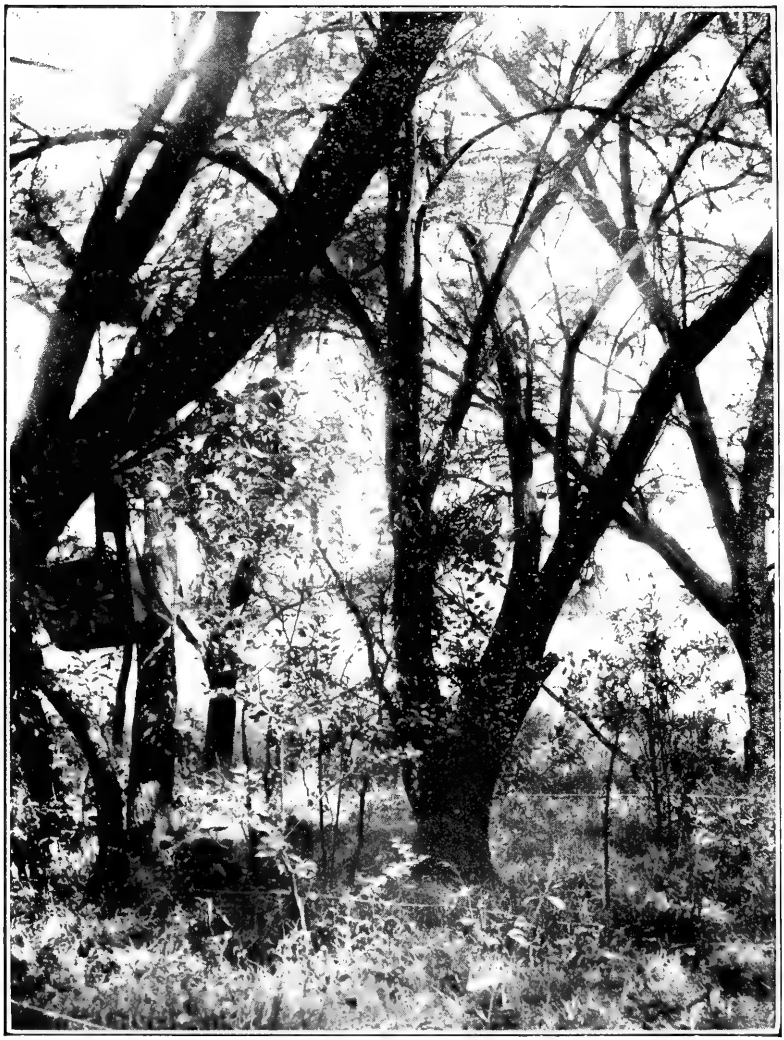


PLATE 11. Acacia bush. Inside view of portion of the belt transect, Fig. IX. Portions of three of the transverse lengths of cord of the transect can be seen. The large trees are *Acacia Karroo*. The taller sapling with narrow leaves, centre, is *Rhus lancea*: another individual of it can be seen to the right. The others are *Celtis rhamnifolia*. In the right foreground is an individual *Achyranthes aspera*. The ground vegetation is mainly composed of *Bromus unioloides* and *Ehrharta erecta*.

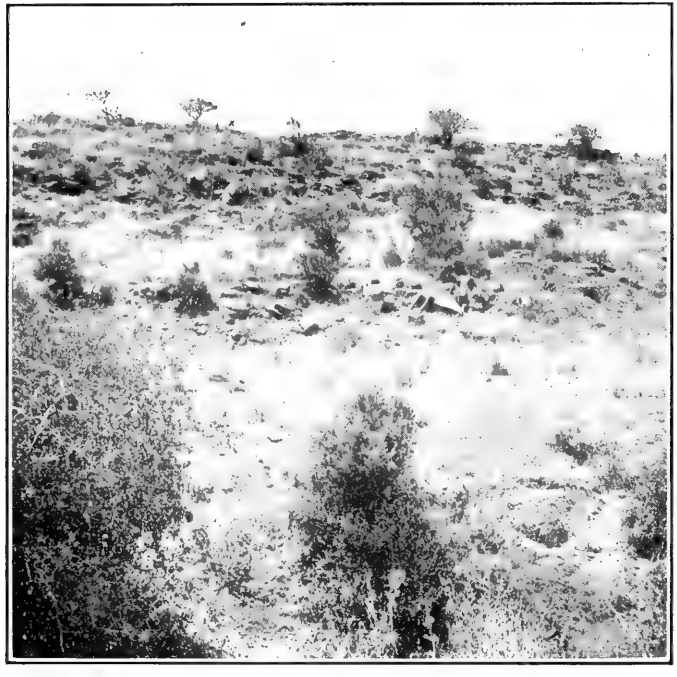


PLATE 12A. View of valley slope facing north, shown in Fig. X. The cross on the horizon marks the distal end of the steel tape of the transect. The tape can be faintly seen stretching down the face of the slope. The trees are *Olea verrucosa*, and the shrubs *Euryops multifidus*. The conspicuous grasses are *Aristida spp*. In the left foreground is portion of *Zizyphus mucronata* shown in Fig. X on the bank of the spruit. To the right is a small *Chilianthus arboreus*, and behind it a number of shrubs of *Euryops sulcatus*.

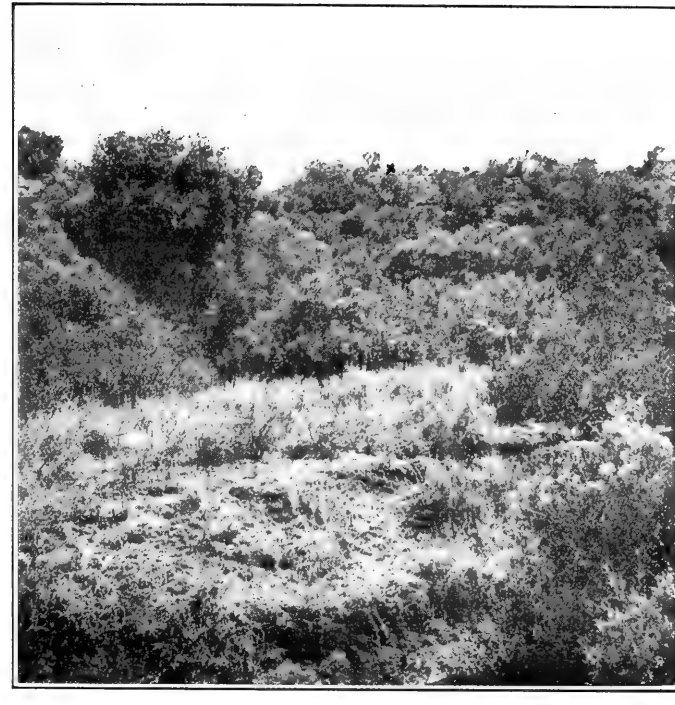


PLATE 12B. Bush-covered valley side facing south (see Fig. X). The large tree to the left is *Celtis rhamnifolia*. To the right, marked by a cross, is *Cussonia paniculata*, shown in Fig. X. The shrubs in front are *Euryops sulcatus*. To the right can be seen *Royena decidua*, and portion of *Rhus pyroides*, Fig. X. In the foreground can be seen portion of the bank of the spruit, and right foreground *Chilianthus arboreus* in flower.

PLATE 13A. Ring of bush developed in the tumbled-down walls of an old military sconce on a treeless bult (Bayswater). The bush-ring is composed of a number of *Chilianthus arboreus*. The grasses are *Eragrostis spp.*, *Aristida spp.*, and *Themeda triandra*. Portions of *Euryops sulcatus* can be seen in the immediate foreground.

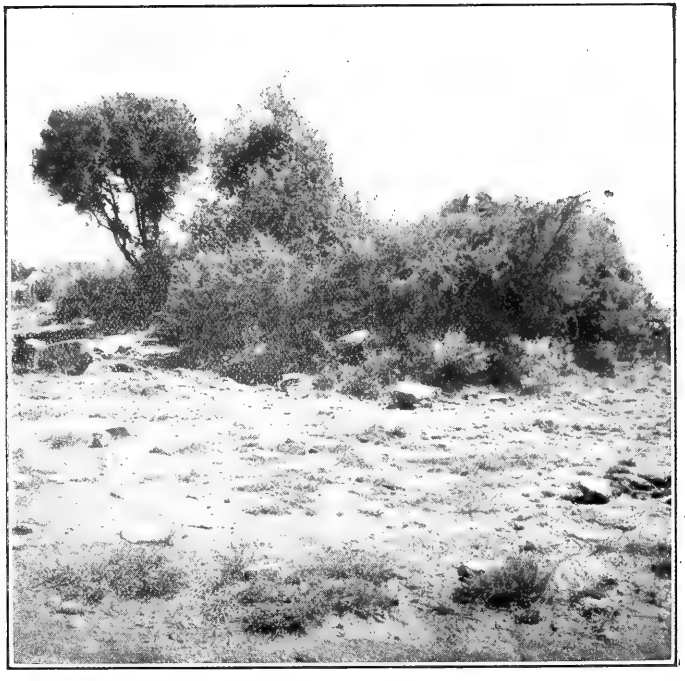


PLATE 13B. Clump of bush on a low bult (Hillside) in a rocky rubble, believed to have been caused by blasting. A number of irregular boulders are seen strewn about the foot of the clump. The tree on the left is *Olea verrucosa*, and to the right of it is another individual of the same species being overwhelmed by *Zizyphus mucronata*. The shorter growth is made up of a tangle of *Zizyphus mucronata* and *Gymnosporia polyacantha*.

MAP No.1

REFERENCE

SCRUB

- *Mesembryanthemum spinosum - Euphorbia mauritanica*
- *Euryops sulcatus - Euphorbia mauritanica*
- *Euryops sulcatus - Themeda triandra*
- *Koppie scrub*
- *Rhus ciliata - Themeda triandra*

THE DISTRIBUTION OF THE ASSOCIATIONS

Approximate Scale. 1 Inch = 560 Yards

- *Disturbed Areas.*

REFERENCE

BUSH

- *Koppie bush.*
- *Spruit - bank - valley bush.*
- *Acacia bush.*

GRASSLAND

- *Valley grassland.*
- *Themeda grassland.*

JOURNAL

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VOL. III.

PLANTAE NOVAE AFRICANAE.

"Ex Africa semper aliquid novi."—*Pliny.*

SERIES VIII.

(With Plate 14.)

By Miss W. F. Barker, B.Sc., and Paymaster-Captain T. M. Salter, R.N. (Ret.)

Haworthia Blackburniae, Barker (Liliaceae-Aloineae), § Fusiformae. *Caulis* simplex, brevis, ad 1 cm. diam., foliorum vetustorum basibus obtectus. *Radices* fusiformes ad medium ad 1·2 cm. diam. *Folia* primum 4—6, plus minusve disticha, deinde ad 10, multifaria, linearia, apice acuta, erecta vel patentia, coriacea, laevigata, glabra, viridia, ad basin rubescentia, ad 15 cm. longa, 0·5 cm. lata, 1 mm. crassa, supra canaliculata, margine cartilagineo-dentata, interdum inflexa, infra convexa. *Pedunculus* simplex, gracilis, brunneus, fere 12 cm. longus, 1·5 mm. diam: bracteae steriles ovatae, acutae, semiamplexicaules, papyraceae, 5 mm. longae, 3 mm. latae. *Racemus* 8—10 cm. longus, floribus fere 15, patentibus, pedicellis erectis 3 mm. longis: bracteae ovatae, acutae, papyraceae, 5 mm. longae. *Perianthium* bilabiatum, tubo leviter curvato, basi brevissime stipitata, 1·5 cm. longum, segmentis ligulatis 6 mm. infra apices recurvis, lacteis, exterioribus nervo viridi-lilaceo, interioribus nervo viride ornata. *Stamina* 4 mm. longa. *Ovarium* pallide viride, 2 mm. longum, 1 mm. diam., stylo 4 mm. longo. *Capsula* oblonga, 8 mm. longa: semina compressa 1·5 mm. longa.

Hab. Cape Province: Oudtshoorn Div.; growing singly in stony ground on a hill about 8 miles from Calitzdorp in quite exposed posi-

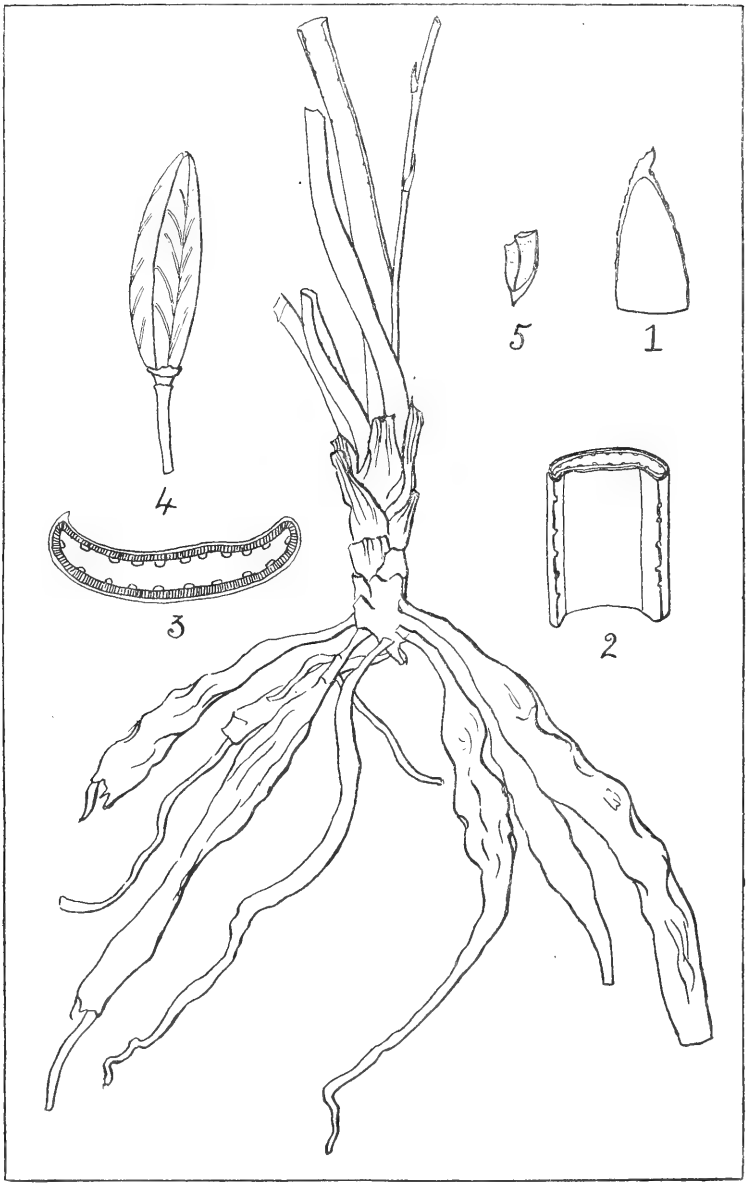


FIG. 1.—*Haworthia Blackburniae*, Barker, natural size. 1. Tip of leaf × 4. 2. Portion of leaf × 4. 3. Transverse section of leaf × 8. 4. Young fruit × 4. 5. Seed × 8. (*Reynolds* 1842 and N.B.G. 1174/36.) Del. W. F. Barker.

PLATE 14. *Haworthia Blackburniae*, Barker.
FIG. 1. Plants in flower at Johannesburg, 18 September, 1936.
FIG. 2. Upper part of raceme, natural size. (Photo., G. W. Reynolds.)

tions, in flower Sept., 1936, *Reynolds* 1842 (Collected by Mrs. H. Blackburn), Nat. Bot. Gdns. 1174/36 (*type* in Nat. Bot. Gdns. Herb.) Nat. Herb., Pretoria ; Calitzdorp, in flower Oct. 1935, *Blackburn*, Bolus Herb. 21933.

This interesting plant was first sent to the Bolus Herbarium from Calitzdorp by Mrs. H. Blackburn in Oct. 1935. It was determined as new but its genus was not decided for although its flowers, fruits and seeds were typical of Haworthia its coriaceous linear leaves and fusiform roots were unknown in the genus. Further material without flowers was sent by Mrs. Blackburn in 1936 to Mr. G. W. Reynolds of Johannesburg. He kept some plants for his rockery and distributed the rest to the National Herbarium, Pretoria, and the National Botanic Gardens, Kirstenbosch. As far as known none of these plants have flowered yet. In Sept. 1936, Mrs. Blackburn sent him some flowering specimens from which he took the accompanying photographs (Plate 14) and the rough notes from which the description was made. One specimen he sent to Kirstenbosch from which the figure was prepared.

Mr. Reynolds says in his notes : " When I first received the plants not flowering and judging by the fusiform roots and linear leaves with minutely dentate margins, I took it to be a Leptaloe new species, but now I have seen the flowers the inflorescence is that of Haworthia."

Miss Verdoorn of the National Herbarium, Pretoria, is also of the opinion that it is best placed under Haworthia, and after due consideration it has been decided to put it into that genus, including it in a new section " Fusiformae " and to name after its discoverer.

Erica haematacodon, Salter (Ericaceae—Ericoideae) § Ephebus.

Planta parva compacta procumbens, aliquantulum musciformis, valde ramosa, ramis tortuosis implexis hirsutis. *Folia* 3-vel 4-nata, linearia, valde revoluta, infra leviter aperta, tanquam inverse angusteque cymbiformia, 4—6 mm. longa, subglauca, hirsuta, pilis introrsis dense ciliata : petioli erecti, basi turgiduli et rubri. *Flores* 1—3-nati, rare 4-nati, ramulos terminantes. *Pedunculi* 1·5—2·5 mm. longi, hirsuti, rubri, bracteis 3 minutis ciliatis basin versus vel infra medium positis. *Sepala* plus minusve anguste ovata, attenuata, superne sulcata, 1·5—2 mm. longa, hirsuta, longe ciliata, rubescentia. *Corolla* obscure sanguinea, late campanulato-cyathiformis, 3 mm. longa, 3—3·5 mm. diam., minute tuberculata, hirsuta, segmentis obtusis fere 0·7 mm. longis. *Stamina* inclusa, filamentis conspicue sigmoideis : antherae oblique ovoideae, apice obtusae, scabridae, 0·4—0·5 mm. longae, poro 3/5 lobi, aristis scabridis cum lobo fere aequantibus. *Ovarium* depresso-globosum, glabrum, stylo incluso, stigmate capitellato.

Hab. Cape Province : Cape Peninsula, on wet ledges and cliff crevices on mountain slopes facing south, 1,500—2,500 ft.; Noord Hoek Mountain, *Pillans* 7612, *Salter* 294/4B ; Zwartkop, near Smitswinkel, *Salter* 294/4A, 6542 (*type* in Bolus Herbarium) ; Constantiaberg, *Bodkin* (Bolus Herb. No. 8061). Flowers Dec.-Jan.

A rare species, confined as far as is known to the mountains of the Cape Peninsula. It has been confused with *E. distorta*, Bartl. and Bodkin's rather poor specimen, which does not show the habit well, was attributed to that species by Dr. H. Bolus who probably never saw the plant growing. *E. distorta*, except in the seedling stage, is an upright plant

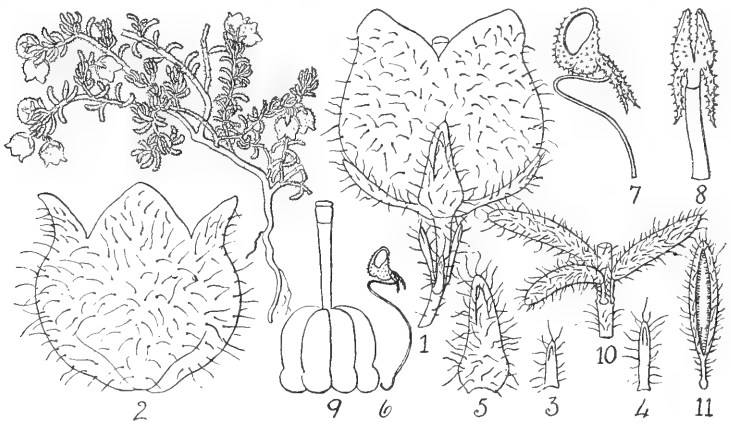


FIG. 2. *Erica haematocodon*, Salter (natural size). 1. Flower × 10. 2. Corolla × 10. 3 and 4. Bracts × 10. 5. Sepal × 10. 6. Stamen (side view) × 10. 7. Anther (side view) × 20. 8. Anther (back view) × 20. 9. Gynaecium × 10. 10. Whorl of leaves × 4. 11. Leaf (back view) × 4. (*Salter* 6542.) *Del.* W. F. Barker.

with virgate branches, whereas *E. haematocodon* grows in dense prostrate greyish moss-like tufts and also differs in its wider sepals, more densely hirsute dull blood-red corolla, patent leaves with erect petioles and much larger anthers and awns.

It has not been recorded from Table Mountain, but very probably it occurs on some of the high ledges inaccessible to the ordinary collector.

Oxalis Fergusonae, Salter (Oxalidaceae), § Tripartitae (Rotundatae).

Planta minuta glandulosa, caule non exserto. *Bulbus* anguste ovoideus vel subuloideo-ovoideus, rostratus, interdum indistincte tortuosus, plerumque longitudinaliter costatus, tunicis rugosis atro-

brunneis : bulbilli aerii basales, numerosissimi, pallidi, in foliorum axillis congesti. *Rhizoma* breve, squamiferum. *Folia* pauca, ad basin imbricata potius quam rosulata, petiolis brevibus 2—8 mm. longis, rarius ultra, sparse glandulosis, ad basin infra articulum dilatatis : foliola 3, sessilia, rotundata, medium 1—2·5 mm. longum, 1—3 mm. latum,

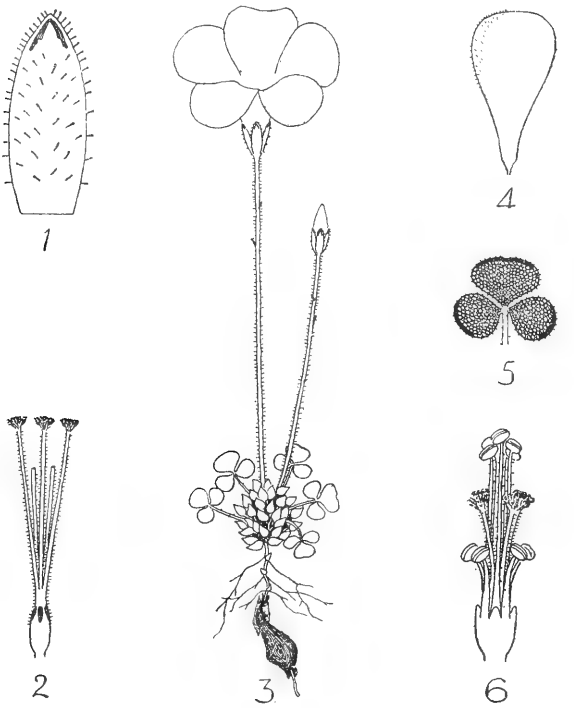


FIG. 3. *Oxalis Fergusonae*, Salter. 1. Sepal × 8. 2. Gynaecium × 5. 3. Plant × 1½. 4. Petal × 1½. 5. Leaf (dry) × 4. 6. Androecium × 5. (*Bolus Herb.* 20176.) *Del.* T. M. Salter.

interdum leviter retusum, lateralia obliqua paulo minora, margine anteriore atro-callosa, in sicco, ob cellulas collapsas, utrinque conspicue foveolato-punctata, glanduloso-ciliata. *Pedunculi* uniflori, plerumque 3—6 cm. longi, pilis brevibus pluricellularibus capitatis pilosi, in parte superiore bibracteati bracteis minutis late alternantibus. *Sepala* oblonga, acuta, 2·5—4 mm. longa, glanduloso-pilosa et ciliata, apice callis 2 conspicuis conventis rubris notata. *Corolla* 1·5—1·7 cm. longa, rosea vel

alba, tubo satis late infundibuliforme luteo : petala cuneata, inferne leviter attenuata, antice rotundata, 7—8 mm. lata, ad marginem exteriorem glanduloso-pilosa et ciliata. *Filamenta* (parte connata inclusa) minora 2·5—4·5 mm., glabra, majora 4—6·5 mm. longa, sparse glandulosa, breviter dentata. *Ovarium* oblongum, 1·5 mm. longum, in dimidio superiore, sicut styli, dense pluricellulari-pilosum, loculis fere 8-ovulatis.

Hab. Cape Province : Riversdale Div. ; near Riversdale, *E. Ferguson* Bolus Herbarium 20176 (*type*), 19204 : Uniondale Div. ; Ongelegen, 2,700 ft., *Fourcade* 5037 : Ceres Div. ; Rozendal (Cold Bokkeveld), *Acock* 2222, rather larger in all parts than the typical form.

Nearest in affinity to *O. punctata*, L., but differing in the shape of the bulb which, though rugose, is not sharply angled and deeply pitted, and in having shorter petioles and two conspicuous elongate converging calli at the apex of the sepals : it also flowers much later than that species.

The production of a congested mass of aerial bulbilli in the axils of the leaves also occurs, though apparently not constantly, in several other species, all of which have the same characteristic semi-succulent leaflets which, on account of the collapsing of the cells, show conspicuous pitting on both sides when dried. They have been observed in *O. inaequalis*, Weintroub, *O. lichenoides*, Salter, *O. Annae*, Bolus f. (= *O. bella*, R. Knuth) in cultivation and in *O. Pocockiae*, L. Bolus in the wild state, but although, according to Jacquin, they occur in *O. convexula*, Jacq.—vide Jacquin's Oxalis, tab. 55 (*not the plants which* Sonder *has erroneously attributed to this species in the Flora Capensis*), I have seen no trace of them in that species either in wild or cultivated plants.

Oxalis rhomboidea, Salter (Oxalidaceae), § Tripartitae (Oblongae).

Planta parva erecta, caule exserto vel rare non exserto, 5—12 cm. alta. *Bulbus* ovalis vel ovoideus, basi apiceque saepe leviter attenuatus, tunicis rigidis atro-brunneis. *Rhizoma* ad 5 cm. longum, squamis parvis paucis indutum. *Caulis* 2—5 cm. longus, glaber, sicut rhizoma squamelliferus. *Folia* 3—8, ad caulis apicem aggregata, petiolis 2—4 cm. longis, glabris vel sparse pubescentibus : foliola 3, brevissime petiolulata, rhomboideo-ovalia vel rhomboideo-ovata, obtusa, lateralia obliqua. 1—2 cm. longa, 0·6—1·1 cm. lata, glabra vel sparse villosa, interdum atro-punctata, supra atro-viridia, infra purpurea (in sicco omnino brunneo-viridia). *Pedunculi* uniflori, plerumque folia aequantes, praecipue in dimidio superiore pubescentes, supra medium in articulo superiore bibracteati bracteis minutis oppositis, apice auriantiaco-callosis. *Sepala* lanceolata, obtusa vel subacuta, plus minusve pubescentia, rare glabra, 3·5—5 mm. longa, interdum apice minute bicallosa. *Corolla* 1·3—1·9

cm. longa, lutea, tubo satis late infundibuliforme concolore : petala e basi breviter unguiculata late cuneato-obovata, apice plus minusve truncata, ad 1 cm. lata, margine exteriore saepe purpureo-striata. *Filamenta* (parte connata inclusa) minora 2·5—4 mm., glabra, majora

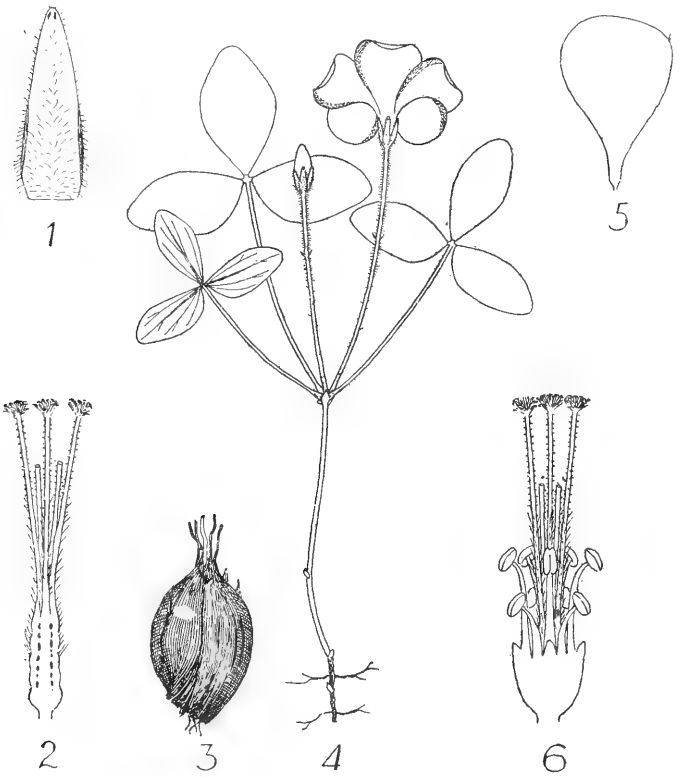


Fig. 4. *Oxalis rhomboidea*, Salter. 1. Sepal × 6. 2. Gynaecium × 6. 3. Bulb, natural size. 4. Plant, natural size. 5. Petal × 1½. 6. Androecium × 6. (*Salter* 930.) *Del.* T. M. Salter.

4·5—7·5 mm. longa, glabra vel minute glandulosa, breviter lateque dentata, longissima e tubo paulum exserta. *Ovarium* oblongum, 1·7—2·5 mm. longum, in parte superiore pubescens et callis parvis purpureis punctatum, loculis 5-ovulatis, stylis inferne pubescentibus, superne glandulosis.

Hab. Cape Province : Van Rhyn's Dorp Div. ; very local on hills near Bitterfontein, *Salter* 930 (*type* in Bolus Herbarium). Flowers June.

An affinity of *O. crispula*, Sond. and with very similar flowers, but it is far less pilose and not nearly such a robust species It differs also in having fewer leaves and much broader flat oval-rhomboid leaflets.

Like *O. crispula* it belongs to the same complex group as *O. rubroflava*, Jacq. and *O. tricolor*, *A*, Jacq., which Sonder included in his ' omnibus ' species *O. mutabilis*, Sond.

Oxalis orbicularis, Salter (Oxalidaceae), § Tripartitae (Rotundatae). *Planta* gracilis ad 12 cm. alta, caule non exserto. Bulbi anguste ovoidei, longe rostrati, seniores praeter rhizoma persistentes ; tunicae atro-brunneae, exteriores saepe diffissae, itaque lineari-ligulatae, valde tortuosae et undulatae. *Rhizoma* glandulosum. *Folia* pauca, basalia, petiolis gracillimis, glabris vel minute glandulosis, 3—6 cm. longis, interdum apice ampliatis itaque minute pulvinatis : foliola 3, suborbicularia, ad basin latissime cuneata, tenuia, breve petiolulata, minute emarginata, margine extremo callis numerosis anguste elongatis atris notata. omnino glabra vel glanduloso-ciliata, supra interdum praeter nervum medium pallidiora vel purpurascentia, infra nervata, saepe purpurea, medium 1·1—1·3 cm. longum, 1·3—1·6 cm. latum, lateralia paulo minora. *Pedunculi* uniflori, folia fere 2-plo superantes, glabri vel minute glandulosi, supra medium in articulo superiore bibracteati bracteis oppositis minutis. *Sepala* oblongo-lanceolata, 3—4 mm. longa, praecipue in parte superiore pilosa et ciliata, apice callis 2 elongatis conventis, rubro-brunneis induta. *Corolla* pallide violacea, 1·4—1·9 cm. longa, tubo luteo : petala cuneato-spathulata, 4—5·5 mm. lata, interdum ad medium margine exteriore anguste purpurascentia. *Filamenta* (parte connata inclusa) minora 2·5—4 mm., glabra, majora 3·5—6·5 mm. longa, sparse glandulosa, edentata. *Ovarium* oblongum, 1·4—1·8 mm. longum, glabrum, stylis inferne pilis simplicibus, superne pilis glandulosis minute pilosis. *Capsula* sepala paulo superans, loculis 3—4-ovulatis.

Hab. Cape Province : Montagu Div. ; damp shady places about Montagu, *Salter* 2323 (*type* in Bolus Herbarium), 1080, 1081, leaves only : Swellendam Div. ; Warm Baths, Barrydale *L. Bolus* Bolus Herb. 21019. Flowers June and perhaps earlier.

A very distinct species and one which is difficult to place as regards its affinity. Artificially it must be included in the subsection Rotundatae, but although the peduncles are 1-flowered, it is probably more closely akin to such species as *O. caprina*, L. and *O. anomala*, Salter in the § Cernuae. It may be readily recognised by its very slender petioles and almost orbicular leaflets, the extreme margins of which are closely

dotted or streaked with elongate calli. In all the plants I have seen growing there is a narrow either pale whitish or dark purple band along the medial vein on the upper surface of the leaflets. Like several other

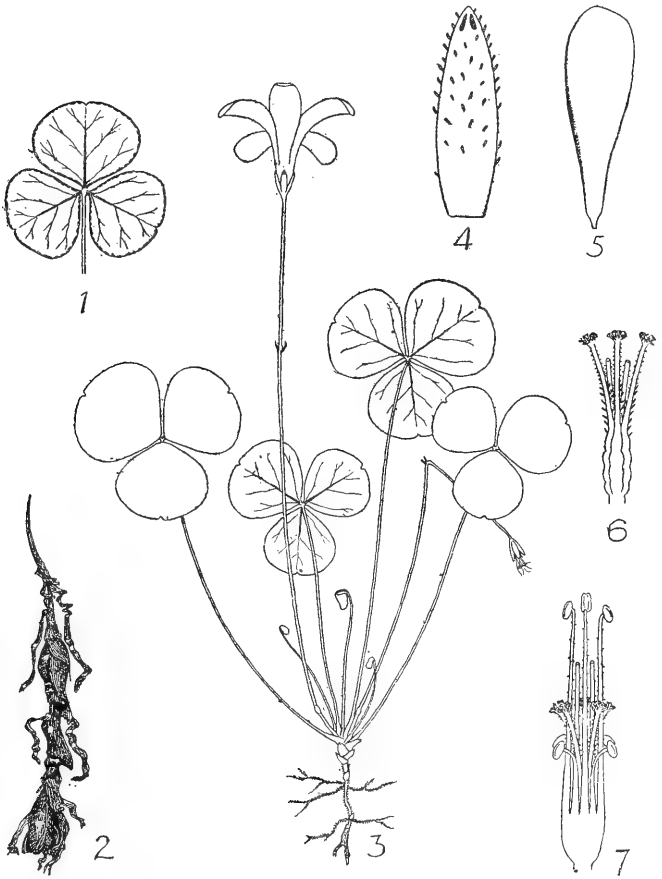


FIG. 5. *Oxalis orbicularis*, Salter. 1. Leaf (underside), natural size. 2. Bulb, natural size. 3. Plant, natural size. 4. Sepal × 8. 5. Petal × 2. 6. Gynaecium × 6. 7. Androecium × 6. (*Salter* 2323.) *Del.* T. M. Salter.

species it seems to be intermittent in its appearance for I have searched in successive seasons in more than one locality where I had previously found it, but without seeing any trace of it.

Oxalis camelopardalis, Salter (Oxalidaceae), § Sessilifoliatae.

Planta erecta, ad 10 cm. alta, caule foliato exserto, partibus herbaceis (nisi tamen sepala ciliata) omnino glabra. *Bulbi* late subuloidei, saepe congesti, 4—5 cm. longi: tunicae satis laxae, lanceolatae vel linearilanceolatae, acutissimae, brunneae, pilis brunneis retrorsis pilosae, interiores pallidiores, nitentes. *Rhizoma* ad 10 cm. longum, pilosum, squamis paucis interdum striatis indutum. *Caulis* ad 7 mm. longus, interdum ramosus, ad basin squamis nonnullis instructus, superne dense foliatus. *Folia* numerosa, in caulis maxima parte dense imbricantia, manifeste recurva, petiolis subsquamiformibus, 1·5—2·5 mm. longis, striis 2 prope margines ornatis: foliola 3, sessilia, anguste linearia, conduplicativo-falcata, minute emarginata, 3—8 mm. longa, infra lineis brevibus numerosis pellucidis (in sicco atris) notata. *Pedunculi* uniflori, satis numerosi, e foliorum inferiorum axillis exorientes, 2·5—7·5 cm. longi, prope basin articulati, rubescentes, paulo infra calycem bibracteati bracteis alternantibus vel subopposititis linearibus, 3—5 mm. longis, sicut folia striatis. *Sepala* late lanceolata, 4—5 mm. longa, rare minutissime ciliata, lineis pellucidis (in sicco atris) longitudinaliter striata. *Corolla* ad 2 cm. longa, intense rubro-purpurea, tubo infundibuliforme luteo: petala e basi unguiculata quam lamina paulo breviore suborbicularia, oblique leviterque truncata, marginem exteriorem versus lineis (in sicco atris) ornata. *Filamenta* (parte connata inclusa) minora 2—2·5 mm., glabra, majora 3—4 mm. longa, sparsissime glandulosa, leviter gibbosa. *Ovarium* glabrum vel ad apicem sparse pubescens, callis atris (in vita pellucidis) copiose notatum, loculis 2—3-ovulatis, stylis inferne sparse pubescentibus, superne glandulosis.

Hab. Cape Province: Caledon—Worcester Divs.; Rooihoogte Pass, *Salter* 2308 (*type* in Bolus Herbarium), 6039: Montagu Div.; *Leipoldt* Bolus Herb. 16061. Flowers June.

This species very much resembles *O. melanograpta,* Salter (illustrated in Vol II, p. 6 of this Journal) having a similar pilose rhizome, but it is a larger plant. It also differs in that the leaves extend nearly to the base of the stem, the corolla is a much deeper colour and the tube longer, the longest stamens not being exserted.

It differs from both *O. pardalis,* Sond. and *O. confertifolia,* (O. Kuntze) R. Knuth in its pilose rhizome. Its leaves are smaller, recurved and more closely imbricate along the stem than in the former, while it is a less robust plant than the latter, never bearing the pseudo-fasciculate leaves which characterise that species.

The trivial name is suggested by the fact that the plant has the same ' leopard-spotting ' as *O. pardalis,* but it is larger and has longer peduncles.

A NEW SPECIES OF HAEMANTHUS WITH A PRELIMINARY NOTE ON THE STRUCTURE OF THE BULB.

(With Plate 15.)

By Frances M. Isaac.

Haemanthus Nortieri, Isaac, sp. nov. (Amaryllidaceae—Haemantheae.) *Bulbus* globosus, long. ad 19 cm., diam. ad 10 cm., in collum productus, distincte lateraliter compressus, tunicis saturate brunneis obtectus. *Folium* unicum, long. ad 27 cm., lat. ad 15 cm., hysteranthum, erectum rotundatum vel obovatum, in petiolum basi attenuatum; lamina sordide viridis, ad basin rubescens, utrinque scabra, in juventute viscosa, margine rubro minute scabro. *Pedunculus* erectus, long. ad 20 cm., diam. ad 1·1 cm., compressus, inconspicue scaber, rubescens. *Umbella* densa, long. ad 4·5 cm., lat. ad 5 cm. *Bracteae* erectae long. ad 4·5 cm., lat. 2·5 cm., sordide rubrae, formis diversis, saepius ovato-lanceolatae, apice acutae. *Flores* erecti, crebri; pedicelli long. ad 2·5 cm. *Perianthium* sexpartitum, roseum; tubus long. 2 mm. angulatus, brevis; segmenta angusta, long. ad 1·5 cm., lat. 1·5 mm., apicibus obtusis incurvis. *Stamina* alba, long. 2·6 cm., e perianthio per 1·1 cm. exserta, bracteis aequantia, in tubi faucibus inserta. *Stylus* albus, demum staminibus aequans. *Stigma* minute trifida. *Ovarium* long. 3 mm., diam. 2 mm., oblongum, triangulatum. *Bacca* rubro-purpurea, seminibus 1—3, ovoideis, rubro-brunneis, nitentibus.

Hab. Cape Province: Clanwilliam Div.; Nardouw Mountains. *Salter* 3622. (*Type* in Bolus Herbarium.) *Nortier* in Nat. Bot. Gdns. 850/35. Flowered in February and March and fruits and leaves appeared in April at Kirstenbosch.

This remarkable *Haemanthus* was first discovered by Dr. P. le F. Nortier of Clanwilliam, and has subsequently been collected by Paymaster-Captain T. M. Salter. It differs from other existing species of the genus by the production of only one leaf each year, and is most closely allied to *Haemanthus undulatus* Herb. which has a similar bulb but produces two narrow undulate leaves.

By the courtesy of Dr. Nortier bulbs were received for dissection. This material indicates some interesting morphological features and it is

hoped to follow up this note with a more detailed study, including comparisons of the structure of the bulbs of other species of this genus.

In all, ten bulbs were carefully dissected and in none of them was any trace found of a second leaf or any rudimentary structure which might be assumed to represent a leaf.

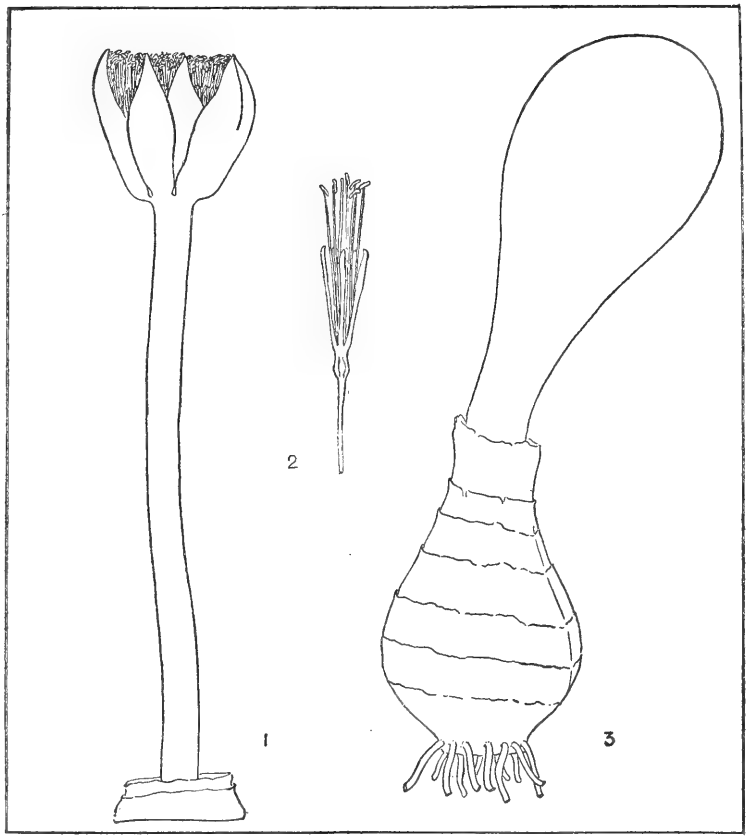


FIG. 1. Haemanthus Nortieri, Isaac. 1. Inflorescence $\times \frac{1}{2}$. 2. Single flower $\times$ 1. 3. Bulb and leaf $\times \frac{1}{4}$.

Each scale completely encircles the bulb and can be differentiated into the actual basal portion of the leaf enclosing one half of the bulb and the sheath enclosing the other. (See Fig. 2, Nos. 1, 3, 7.). The bulb being laterally compressed in the same plane as the leaf surface, a trans-

PLATE 15. (Top) Haemanthus Nortieri, growing wild on the Nardouw Mountains, about 1,100 ft. alt., September, 1933. (Phot. T. M. Salter.) (Bottom) Haemanthus Nortieri, in cultivation at Kirstenbosch, September, 1936. (Phot. R. H. Compton.)

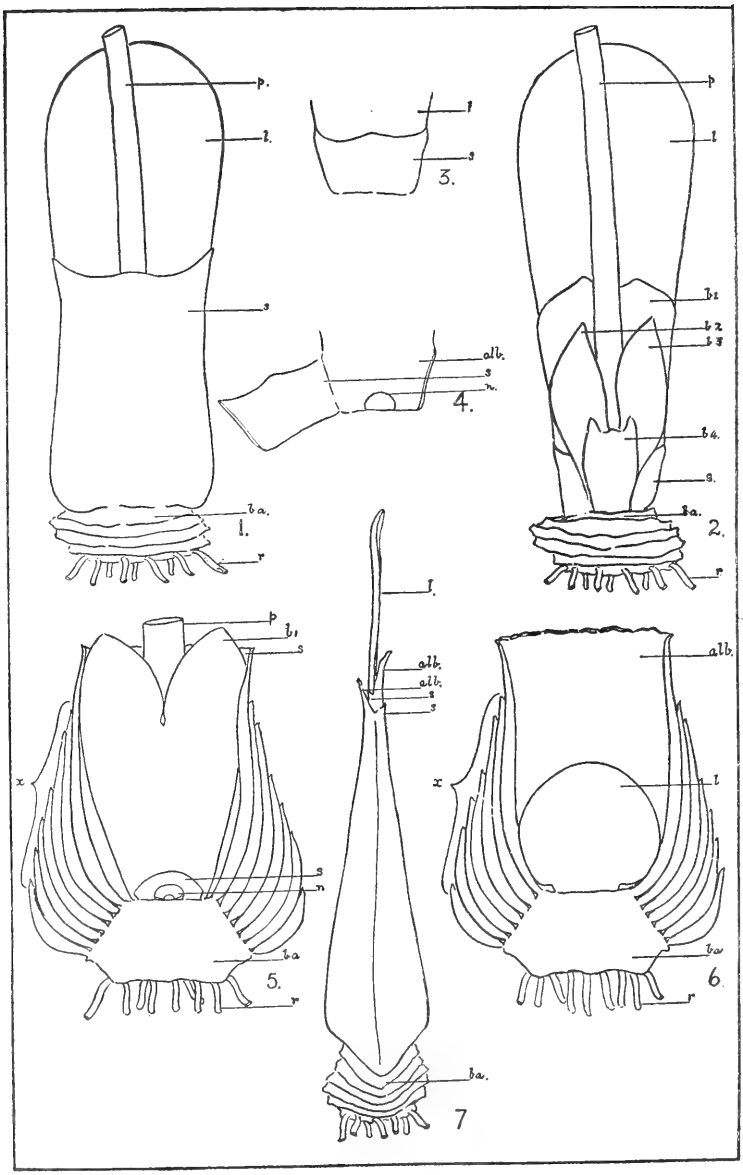
verse section of a scale gives a flattened ellipse, one side of which may be called the actual leaf base and the other, which is less thickened and composed of softer tissue, the sheath. By ringing carefully the bases of the scales close to the axis they were removed in one piece. Because of this clearly marked differentiation of the sides of the scales, it was easy to trace, from the most recent to the oldest leaf scale at the base of the axis, the direction in which each leaf produced by the bulb had faced.

At the base of the peduncle four bract-like structures are produced. Similar structures occur in all species of Haemanthus which have been investigated and were figured and described by Thilo Irmisch in 1860.[1] The interpretation and relationships of these will be dealt with in a subsequent paper. These structures persist for a time, varying apparently in different species, between the bulb scales and close to the basal axis. From these it is possible to trace back the years in which the bulb produced a flower. In *Haemanthus Nortieri* it was only possible to trace two years' flowers ; but in *H. rotundifolius*, Gawl. the remains of brown semi-decomposed bracts have been seen on the bulb axis representing the flowers, or potential flowers, of the past twelve years. The explanation of the disappearance of these traces from the bulbs of *H. Nortieri* may lie in the fact that the leaf-sheath, growing from the base of the bulb to the ground level after the bract-like structures have withered, may carry them up with it. An endeavour will be made to clear up this point by observing the plants growing in the National Botanic Gardens at Kirstenbosch.

From the successive position of the leaves and the ability to tell when a flower has been produced, the following fact has emerged. When in any given season a bulb of *Haemanthus Nortieri* does not produce a flower, that season's leaf (following immediately after the flower) faces in the opposite direction to that of the previous season. (See Fig. 2, No. 7.) If a flower is produced, the leaf following it is in the same position a little higher on the axis than the one which preceded the flower. From Fig. 2, Nos. 1, 2, it can be seen that this season's leaf and last season's leaf occupy corresponding positions on the bulb axis, a flower having been produced between the withering of last, and the growth of this season's leaf. Within the sheath of this season's leaf, at the stage shown in Fig. 2, Nos. 4, 5, next season's bud is already well-developed.

Description—Bulb tunicated, up to 19 cm. long and 10 cm. in diam., oblong-globose, produced into a neck, laterally compressed, covered with dark brown scales. Leaf 1, hysteranthous, erect, rotundate or obovate, narrowed into a petiole at the base, blade dirty green, basal part reddish,

(1) Beiträge zur Morphologie der Amaryllideen.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margin red and slightly scabrid ; both surfaces of the leaf scabrous and slightly viscid when young. Peduncle erect, compressed, faintly scabrous, reddish in colour, up to 20 cm. high and 1·1 cm. in diameter. Umbel dense, up to 4·5 cm. high and up to 5 cm. across. Bracts erect, dull red, varying in shape, usually ovate-lanceolate with acute apices, up to 4·5 cm. long, and 2·5 cm. broad. Flowers erect, crowded. Pedicels up to 1·4 cm. long. Perianth six-parted, rose-coloured ; tube short and angular, 2 mm. long ; segments narrow, apices obtuse and incurved, up to 1·5 cm. long and 1·5 mm. broad. Stamens white, 2·6 cm. long, exserted beyond the perianth segments for 1·1 cm., equalling the bracts in length and inserted in the throat of the perianth tube. Style white, finally as long as the stamens. Stigma minutely trifid. Ovary oblong, three-angled, 3 mm. long, 2 mm. in diam. Berry reddish purple. Seeds ovoid, shining, red-brown in colour, 1—3 in each berry.

In conclusion I wish to thank Dr. P. le F. Nortier of Clanwilliam for providing the material for this work, Dr. L. Bolus for facilities in the Bolus Herbarium and Prof. R. H. Compton for checking my observations.

FIG. 2. All $\times\frac{1}{2}$. *s*, sheath ; *p*, peduncle ; *r*, root ; *l*, present season's leaf ; *b.a.*, bulb axis ; *a.l.b.*, actual base of leaf ; *n*, next season's bud ; *x*, bulb scales ; *b*1, *b*2, *b*3, *b*4, bractlike structures.

1. Bulb with all the scales removed except that formed by last season's leaf. 2. Bulb with all the scales removed, showing the bract-like structures at the base of the peduncle and the sheath of the present season's leaf. 3. The base of the leaf and the sheath. 4. The sheath cut away to show next season's bud within it. (1, 2, 3 and 4 were all drawn from a bulb in fruit with the leaf appearing.) 5 and 6. The halves of a bulb sectioned when in flower. In 5 the sheath of the leaf about to grow up is seen enclosing next season's bud. In 6 the size of the leaf is shown at the flowering period. 7. A bulb in profile with all the scales cut away except the two most recent. The arrangement of the leaves is alternate—no flower having been produced in the past two years.

NOTES ON SOME SPECIES IN THE FAMILY RUBIACEAE IN THE CAPE PENINSULA.

By Paymaster-Captain T. M. Salter, R.N. (Ret.).

Anthospermum, Galium, Nenax and Carpacoce (including a new species).

Little attention seems to have been paid to the small shrubby Rubiaceae of this district since Sonder's revision appeared in the Flora Capensis, Vol. III, in 1865. Very naturally, considering the very limited quantity of herbarium material at his disposal in Europe and the fact that he knew nothing about the plants in the field, there are inaccuracies in his work. I am here putting on record the result of a rather more intensive examination of some of the species which occur in the Cape Peninsula.

Most of these plants are rather inconspicuous, the flowers being almost invisible except on close examination, and, on account of their general resemblance to the prevailing ericoid-leaved vegetation, they are often passed over by collectors who have not an "eye" for them. Again, the examination of herbarium specimens reveals the fact that more often than not in the dioecious species only one sex has been collected, whereas to obtain a good knowledge of these plants it is often necessary to collect a quantity of specimens in different stages of development.

The complex genus *Anthospermum*, which is wide spread in South Africa, contains many yet unnamed species and would well repay a close study, but a great deal more well-collected material and field observation is required before an attempt at its revision can be advised.

In the genera *Anthospermum*, *Carpacoce* and *Nenax* the female plants have very much smaller corollas than the males and do not show any male elements, but the so-called male plants are often protandrous-hermaphrodite or at least show some female elements, while plants are sometimes found with pollenless anthers, functioning as females.

In some cases no dependence can be put upon the characters given in Sonder's keys.

Anthospermum aethiopicum, L. A very common plant in which colonies with ternate *outer whorls* of leaves are just as common as those having all the leaves opposite. In no other respect is there any constant difference and, in view of the great variability in this species, it seems that var. *oppositifolium*, Cruse, is scarcely worth distinction as a variety.

A rather smaller more bushy variety with smaller leaves occurs on the Lion's Mountain, which seems to agree fairly well with the description of var. *montanum*, E. and Z., of which I have not seen the type.*

The species appears to be purely dioecious with no indeterminate males and the flowers are always tetrandrous.

Anthospermum prostratum, Sond. The male corollas are usually 4-lobed but occasionally some with 5 lobes occur, in which case the flowers are pentandrous. No 5-lobed female corollas have been found. Occasional seed-producing hermaphrodite flowers occur on the male plants, but they are somewhat rare.

The varieties *velutinum*, Sond. and *glabrum*, Sond. are not worthy of retention. The stem and branches in all the living plants examined are downy, but occasional plants growing in association have distinctly downy fruits, though otherwise indistinguishable.

Anthospermum ciliare, L. The male or hermaphrodite plants show the greatest variation in degree of sex. Entirely male flowers and fertile hermaphrodites may be found on the same plant.

Var. **papillatum,** Sond., which is common in the southern half of the Peninsula, is very distinct, for besides having papillate fruits, the leaves are entirely without cilia. It is possibly worthy of specific rank, but owing to the number of variants under this species, growing all over the South-Western District, more investigation of the "group" is required before giving it a name.

Anthospermum Bergianum, Cruse. The lower leaves are often opposite, the outer whorls of the upper being 3-nate or rarely 4-nate. The majority of the plants are purely male and female, but fertile hermaphrodites occur, some with pollenless anthers.

Anthospermum hirtum, Cruse. The corolla in the female sometimes has only 4 lobes. Seeds are rarely produced in the hermaphrodite flowers except in occasional plants where all the anthers are pollenless.

Galium tomentosum, Thunb., the only indigenous species known in the Cape Peninsula, is dioecious, the female only producing the long white-villous peduncles which gave the species its name. Though the flowers appear at first sight to be perfect the anthers are without pollen.

The male plants, hitherto considered a different species and known as *G. asperum*, Thunb., differ only in having short pubescent peduncles and, though the flowers have rudimentary female organs, they develop no seed. After examining a large number of plants in the field, I found one only which was intermediate in sex, a phenomenon not unexpected in this family.

* The author would be glad to hear from any Herbarium having Ecklon and Zeyher's specimens of this variety and to forward specimens of the local form for comparison.

Specimens vary a great deal both in the hairs on the stem, some being almost tomentose and others glabrous, and in the development of the reversed prickles. In the more hairy specimens (the Cape Peninsula form) these prickles are almost obsolete.

I am indebted to Mr. C. G. Alm, at Uppsala, for re-examining Thunberg's types and confirming my opinion.

It is significant that Sonder has divided Ecklon and Zeyher's specimens (2323), both sexes collected together, between these two species, but his reference to the *fruit* in *G. asperum* (not mentioned by Thunberg) is difficult to understand. It may be stated, perhaps, without comment, that there are a large number of flower buds on Thunberg's type and that such buds rather resemble fruits unless closely examined.

Galium Aparine, L. This annual is said to have occurred formerly as a weed of cultivation, but it appears to have now died out as such, finding the climate too dry. It was, however, recently found growing at Kirstenbosch in a dampish place half-way up Table Mountain, where the adhesive fruit may perhaps have been carried by some bird and, finding this habitat more congenial, it has continued to exist.

Nenax, Gaertn. The genus Nenax was founded by Gaertner, who described and illustrated the fruit of a plant in Banks' herbarium, collected by Masson, erroneously attributed to the genus Cliffortia (*C. acerosa*). *Gaertn. de fruct. et sem.* pl. 1, p. 165, t. XXXII. f. 7.

This plant, the type of *Nenax acerosa*, Gaertn. (now in the British Museum Herbarium) has recently been examined on my behalf by Mr. N. S. Pillans, who informs me that it is without doubt the species hitherto known as *Ambraria glabra*, Cruse, a plant well known to both of us, which is by no means uncommon in the Cape Peninsula and its environs.

There has, it seems, always been a considerable amount of ambiguity in connection with these two genera. Although it is possible that Cruse overlooked the older genus Nenax altogether (*Cruse Dissert. Rub. Cap.*, pp. 16, 17), Sonder in *Flora Capensis* has followed Cruse, but has quoted Nenax as a synonym of Ambraria, allotting the specific name *acerosa* to *Ambraria acerosa* (*Nenax acerosa*, E. and Z. 2319), which is a very different species from *Nenax acerosa* of Gaertn.

Cruse based his description of *Ambraria glabra* on a female specimen in fruit, collected by Berg at the Cape of Good Hope (now in the Berlin Herbarium) and by some inexplicable error he has described the leaves, which are opposite, as ternate and Sonder has not only repeated this mistake in his key to Ambraria, but has added to it by describing the leaves as " 6—12 in a whorl," at the same time attributing here E. and Z. 2317, which also has opposite leaves.

I am indebted to Dr. L. Diels at Berlin for the loan of Berg's specimen

to Kew, where Dr. H. G. Schweickerdt kindly examined it for me and found the leaves to be opposite, informing me at the same time that the specimens *Levyns* 5289 and *Salter* 5655, sent for comparison, are undoubtedly the same species. It is evident that these errors which have stood uncriticised for years have made the identification of this plant impossible without reference to the types.

Owing to the very inadequate existing descriptions of this species (indeed the male plant has never been described) a full revised description of the living plant (*Salter* 6376), with a drawing, is appended. (Fig. 1.)

Nenax acerosa, Gaertn. (A revised and amplified description.) *Cliffortia acerosa*, M.S., in Herb. Banks ;—*Ambraria glabra*, Cruse. A small perennial dioecious shrublet, 15—30 cm. high, many stemmed from a thick ligneous root and often branched above. *Stem* woody in the lower part, obscurely 4-angled, herbaceous, puberulous or glabrescent and often reddish in the younger branches. *Leaves* opposite, linear, flat above, keeled below, scabrid, mucronate, often minutely seto-ciliate, 0·8—1·5 cm. long, usually longer than the internodes, perfoliately linked at the base, closely congested in 1—4 successive pairs in the axils and appearing to be fasciculate at the nodes. *Stipules* none or very minute. *Inflorescences* in two opposite congested dichasial cymes in the upper leaf axils, from 2—6 flowers arising at each node and appearing verticillate.

Female corolla up to 1·5 mm. long with 5 (rarely 4) broadly lanceolate erect reddish-yellow lobes, 1—1½ times as long as the tube. *Stamens* none. *Stigmas* 2, densely hirsute, about 7 mm. long, greyish-lilac, with no apparent styles. *Ovary* obovate, subangular, crowned with 5 short thick persisting calyx-lobes. *Fruit* obovate, hard, glabrous, about 4 mm. long, obscurely angled, 4-locular, or, by the fusion of the two vacant cells 3-locular. *Seeds* 2, erect, with basal placentation, solitary in two of the cells.

Male. Usually pentandrous, rarely tetrandrous. *Calyx* minute, obconic with 5 small lobes. *Corolla* 5—6 mm. long, the tube 1·5 mm. long, the lobes linear-oblong, dull yellow obscurely veined with red, rolled backwards, with papillose incurved tips. *Stamens* exserted : filaments filiform, 3—4 mm. long, adnate to the corolla tube in its lower half : anthers oblong, tinged with purple.

As is the case with many of the dioecious Rubiaceae in South Africa, some plants with the male or large corolla have been found to possess hermaphrodite elements either in some or all of the flowers. These vary in progression from those with perfect anthers and only rudimentary ovaries and stigmas to those which have pollenless anthers and are fertile as females. No variations have been found in the purely female plants.

A number of plants observed were stunted and probably affected by grazing. Var. *β tulbaghica*, Sond. is evidently only an ungrazed luxurious form.

Hab. Cape of Good Hope ; *Bergius* (in Berlin Herbarium) : Cape Peninsula ; *Levyns* 5289, Buffels Bay ; *Salter* 5655, 5689, Kenilworth ; 6376, Kommetje ; *Bolus* 4997, Cape Flats ; *L. Bolus* Bol. Herb. 21813, Koeberg Road ; *E. and Z.* 2317, Doornhoogte : Caledon Div. ; *Schlechter* 7947 pars., Elandskloof : Worcester Div. ; *Van Breda* 169 : Tulbagh Div. ; *Zeyher* (Tulbagh Waterfall) var. *tulbaghica*, Sond. : also in the opinion of Dr. Schweickerdt, at Kew, *Harvey* 425 and 455. Flowers Sept.-Nov.

That all the existing species of Ambraria belong to the genus Nenax I have no doubt, and I therefore propose the new name **Nenax divaricata**

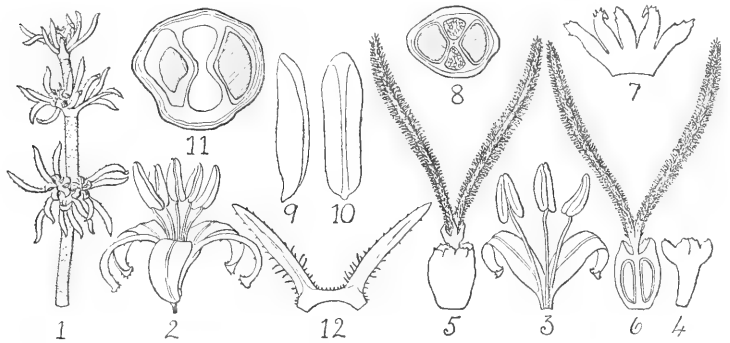


Fig. 1. *Nenax acerosa*, Gaertn. 1. Portion of male plant (natural size). 2. Male flower (side view) × 5. Portion of the male corolla with the stamens attached × 5. 4. Calyx of male flower × 20. 5. Female flower × 5. 6. Longitudinal section of female flower × 5. 7. Corolla of female flower, laid out × 10. 8. Cross section through ovary × 10. 9 and 10. Ovules × 5. 11. Cross section through fruit × 5. 12. Pair of leaves, upper side, laid out × 2 (*Salter* 6376). *Del.* W. F. Barker.

in place of *Ambraria acerosa*, Sond. The following new combinations are also necessary :—

Nenax microphylla, (Sond.) Salter (comb. nov.).

Nenax hirta, (Cruse) Salter (comb. nov.).

Nenax Dregei, L. Bolus is correctly named.

Carpacoce vaginellata, Salter. sp. nov. (Rubiaceae—Anthospermeae.)

Herba parva rigida, scabra, dioecio-polygama, saepius 15—20 cm. alta. *Folia* imbricantia, linearia, vix pungentia, scabra, opposita, basi perfoliate connata ; vaginella 2—3 mm. longa : stipulae minutae vel obsoletae. *Flores* axillares, solitarii, subsessiles. *Calyx* lobis 5 foliaceis, aequalibus, ovario paulum longioribus. Flores hermaphroditi ; *Corolla*

fere 5 mm. longa, segmentis 5, tubo valde longioribus, saepius perfecti, stigmate fere 1 mm. longo, nunc ovario styloque subobsoleto, nunc antheris obsoletis et ovario fecundo. Flores feminei ; *corolla* ad 1·5 mm. longa, lobis 5 cum tubo subaequantibus. *Stigma* unicum subsessile, fere 1·1 cm. longum, lilaceum. *Fructus* uniloculatus : semen solitarium, 3 mm. longum.

A small erect rather rigid dioecio-polygamous herb, many-stemmed from a ligneous root, up to 30 (often 10—20 cm.) high. *Stems* woody, glabrous below, often branched and papillose-scabrid above. *Leaves* im-

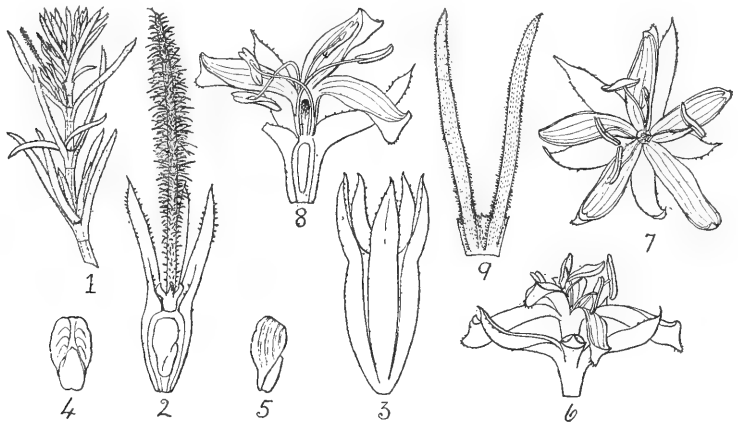


Fig. 2. *Carpacoce vaginellata*, Salter. 1. Portion of female plant (natural size). 2. Longitudinal section through female flower × 4. 3. Fruit × 4. 4 and 5. Inner portion of the fruit (containing the seed) with the outer ribbed portion removed and showing the tubercle × 4. 6. Hermaphrodite flower, side view × 4. 7. Hermaphrodite flower, front view × 4. 8. Longitudinal section through hermaphrodite flower × 4. 9. Pair of leaves × 2. (Salter 6271.) *Del.* W. F. Barker.

bricating, opposite, closely congested in 1—4 successive pairs in the opposite axils, thick, linear, perfoliately linked at the base into a somewhat loose funnel-shaped sheathing tube 2—3 mm. long, subpungent-mucronate, scabrid, cartilagineo-papillate on the margins, the female 1—2 cm. long, the hermaphrodite rather shorter. *Stipules* minute, often absent. *Flowers* subsessile, solitary in the upper leaf axils. *Calyx* of 5 equal leaf-like lobes somewhat longer than the ovary, or shorter in the fruiting stage. *Corolla* 5-lobed, obscurely yellow, often streaked with red.

Hermaphrodite Flowers. *Calyx* lobes spreading. *Corolla* about 5·5 mm. long, the oblong-lanceolate spreading or recurved lobes hooded at the apex on the upper side, much longer than the tube : stamens well

exserted, the filaments arising from near the base of the tube : anthers versatile. Varying in every degree from those with sterile anthers and fertile female organs to fertile males with only a rudimentary stigma, but usually with perfect flowers in which the stigma is thick and only about 1 mm. long.

Female Flowers. *Calyx* lobes erect. *Corolla* up to 1·5 mm. long, the sub-erect lobes equal to or shorter than the tube. *Ovary* obconic, 2—3 mm. long, 5-grooved, 1-chambered with 1 basal ovule. *Stigma* one, almost sessile, densely hairy, greyish or lilaceous, about 1·1 cm. long. *Fruit** narrowly obovate, 5 mm. long, crowned by 5 persisting calyx lobes. Ovary wall splitting into two layers in the fruit : the endocarp becoming detached with the seed and being furnished with a much swollen tubercle partially embedded at the base. (Fig. 2.)

Note.—On one plant out of a great many examined (a dwarf with condensed shoots and darker foliage) two of the flowers were found to have 2 styles and a 2-chambered ovary.

Hab. Cape Province : Cape Peninsula ; Muizenberg Mountain, *Salter* 6271 (*type* in Bolus Herbarium), 275/1 A and B, 275/2, 2681, 2823, 6432, 6489, *Humphrey-Smith* Bol. Herb. 21633 !, *Wright* 530 : Stellenbosch Div. ; ? Hottentots Holland, *Eck. and Zey.* 2313 ! : Bredasdorp Div. ; *Schlechter* 7649 ! , *Bolus*, Bol. Herb. 21875 ! : Riversdale Div.; on Kampsche Berg, *Burchell* 7070, 7124 : Knysna Div. ; *Burchell* 5638 : Humansdorp Div. ; *Galpin* 4104 (ex parte) ! : Grahamstown Div. ; Dassies Klip, *Bolus* 2670 ! : Port Elizabeth Div. ; *Holland* 3856 ! : Bathurst Div. ; *Burchell* 3991. Many of the above consist of only one sex. Flowers April-August.

This plant is widely distributed in the Southern coastal area from Cape Town as far east as Bathurst and has long been confused with *C. scabra*, Sond (type *Anthospermum scabrum*, Thunb.) a species superficially very much like it. *C. scabra* has a 2-chambered ovary with two rugulose whitish-grey seeds, one in each chamber, the calyx lobes vary from 5 to 7 and the leaf pairs are only *very shortly* connate at the base.

I am indebted to Mr. C. G. Alm, at Uppsala, for kindly re-examining Thunberg's specimens of *Anthospermum scabrum* in comparison with examples of my type collecting (*Salter* 6271) and he has confirmed that the differences are as pointed out above.

C. scabra is represented in the Bolus Herbarium by *Bolus* 9054, Clanwilliam (Wupperthal) male and *Compton* 2791, Laingsburg (Witteberg) female in seed, both of which, Mr. Alm informs me, correspond perfectly with the type (*Anthospermum scabrum*, Thunb.). It seems to

*See page 117 of this Journal: " The Ovary and Fruit of Carpacoce," by Margaret R. Levyns, to whom I am much indebted for the microscopic investigation of the fruit of this genus.

have its habitat in the drier inland areas where Thunberg may well have collected it on his travels.

It is evident that Sonder (Flor. Cap. III, p. 33), did not suspect the difference between these species, for he attributes *Eck. and Zey.* 2313 to *C. scabra*, whereas this plant is 1-seeded and is undoubtedly the same as my own. Unfortunately I have not seen the other specimens which Sonder quotes (*Bergius, Mundt and Maire*) and I am unable to place them, but they can no doubt easily be determined by the character of the leaf-sheaths. I am indebted to Dr. H. Schweickerdt at Kew for his kindness in identifying *Burchell's* and *Wright's* specimens quoted above.

C. vaginellata has the typical ericoid leaves of the South-western flora and, though a very inconspicuous plant, it is to be found in many localities in the Cape Peninsula. It seems to flower but rarely, usually when unencumbered by surrounding vegetation and most often in fairly recently burnt areas, the separate sexes being on many occasions found alone. I have searched the "type" locality intermittently during the last eight years but it was not until 1936 that I succeeded in finding both sexes flowering in association on a piece of ground which had been fairly recently burnt and, although the plant was plentiful on the unburnt ground in the vicinity, only one or two flowering females could be found. A large colony of old plants occurs on the south slopes of Vasco da Gama Peak, near the Cape of Good Hope, which I have examined thoroughly in three successive seasons, without finding any trace of flowering.

Carpacoce spermacocea, Sond. is a lax plant, common in marshes and moist sheltered places in the Cape Peninsula. The great majority of the plants have the large or male form of corolla with all the flowers protandrous-hermaphrodite, but very rarely purely female flowers with smaller corollas are found on them. I have only found one plant on which all the flowers have the small corolla and are pure females without anthers. It would have been more appropriate to retain *Ecklon's* specific name "foetida" for this species on account of its nauseating scent.

The following is a key to the four known species of Carpacoce :

Ovary 2-chambered ; ovules 2, solitary in each chamber : leaf pairs shortly connate at the base .. .. .. *scabra*

Ovary 1-chambered ; ovule 1 : leaf pairs connate into a distinct sheath at the base.

A lax foetid plant : calyx lobes unequal : stipules cleft into bristles .. .. *spermacocea*

A rigid upright plant : calyx lobes equal : stipules minute or absent.

Corolla lobes and stamens 5 .. .. *vaginellata*

Corolla lobes and stamens 6 to 7 .. .. *heteromorpha*

THE OVARY AND FRUIT OF CARPACOCE.

By Margaret R. Levyns.

Some time ago Paymaster-Captain T. M. Salter drew my attention to certain peculiar features of *Carpacoce vaginellata*, a new species belonging to the tribe Anthospermeae of the family Rubiaceae. In the Flora Capensis Sonder, when constituting the genus Carpacoce, stated that there was only one style but that the ovary was two-chambered and had two ovules. He then went on to say that the fruit was two-seeded and separated into two portions when ripe, but that it might be one-seeded by abortion. Bentham and Hooker in the Genera Plantarum agreed with Sonder with regard to the ovary but described the fruit as having a coriaceous exocarp which separated from a crustaceous, wrinkled inner portion. This latter was stated to be one-chambered and one-seeded. These authors concluded by saying that they had never seen a two-chambered fruit such as that described by Sonder. Phillips in the Genera of South African Flowering Plants adopts Sonder's description of the ovary and fruit.

An examination of the fruits of *C. vaginellata* showed that Bentham and Hooker's account was substantially correct for the fruit of that species at any rate. Unfortunately, as is pointed out by Captain Salter in a paper published concurrently with this,* *C. vaginellata* is erratic in its flowering habits, and flowers in all stages of development were not available for study. However, it was found that the much more common species, *C. spermacocea* agreed with *C. vaginellata* in all essential features of its ovary and fruit. The following account, which is based on a study of flowers and young fruits of *C. spermacocea*, may therefore be taken to apply to both species in all but unimportant details.

Development of Ovary and Fruit of C. spermacocea.

Careful dissections of the ovary in young flowers have failed to reveal the two-chambered structure supposed to be characteristic of this genus. During the ripening of the fruit the ovary wall becomes differentiated into an outer leathery layer (the exocarp) and an inner crustaceous layer (the endocarp). The whole inner portion bounded by the endocarp is easily detached and may be mistaken for the seed which lies within. A

*Notes on some species in the family Rubiaceae in the Cape Peninsula.—Journal S.A. Botany III p. 109, 1937.

view of this structure after the removal of the exocarp is given in Fig 1, and it will be noted that the much wrinkled endocarp is grooved down one face and hollowed out at the base. A swollen, somewhat spongy tubercle (Fig. 1 *x*) fills this hollow and in the view depicted is partially

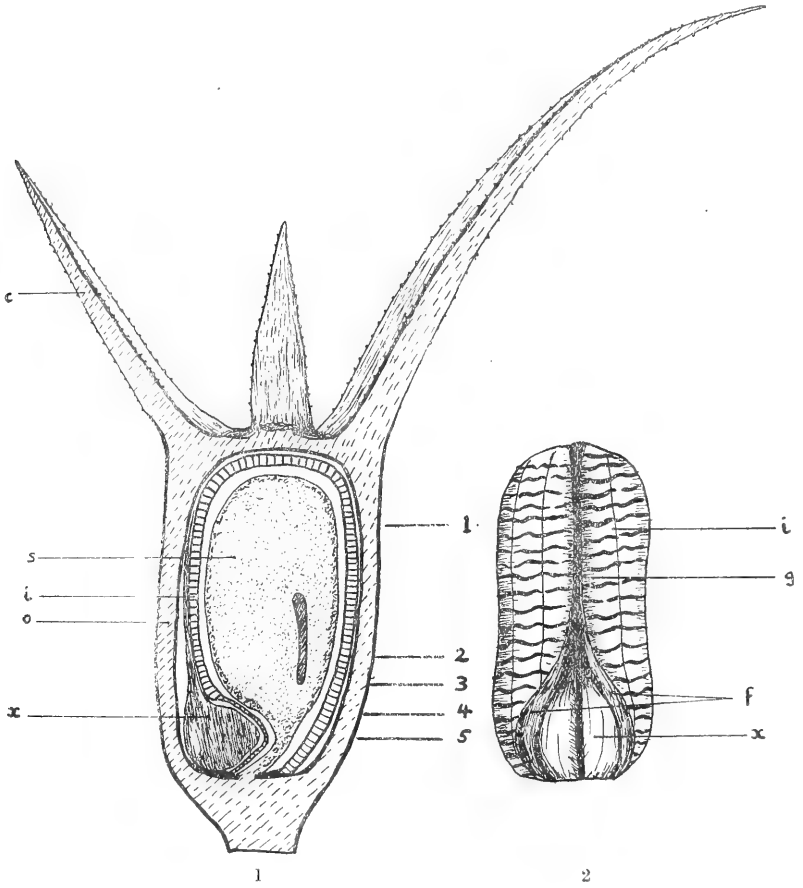
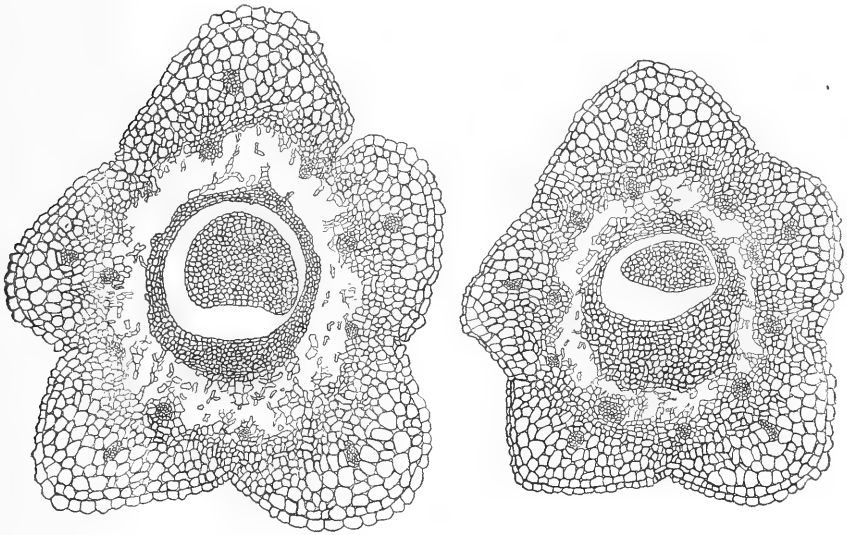


Fig. 1. *Carpacoce spermacocea*. View of the fruit, with the outer layer of the ovary wall removed, facing the parenchymatous swelling × 15. *i*, wrinkled inner layer of the ovary wall; *f*, flap-like extension of inner layer; *x*, parenchymatous swelling; *g*, groove.

Fig. 2. *Carpacoce spermacocea*. Diagrammatic representation of a median longitudinal section through the young fruit × 15. *s*, young seed with embryo; *i*, inner layer of ovary wall; *o*, outer layer of ovary wall; *x*, parenchymatous swelling; *c*, lobe of calyx. The positions marked 1—5 indicate the approximate levels at which the sections illustrated in Figs. 3—10 were obtained.

enveloped by non-wrinkled extensions of the endocarp (Fig. 1 *f*). In the ripe fruit the tubercle is easily detached. Fig. 2 is a diagram of a median, longitudinal section through the fruit showing the relative positions of the parts. It will be seen that the young seed, which occupies the centre of the fruit, has its funicle bent and pushed to one side by the tubercle.

In view of the facts that a two-chambered ovary is the rule in Rubiaceae, and that this genus clearly possesses a single chamber, it was thought desirable to trace the development of the ovary in order to

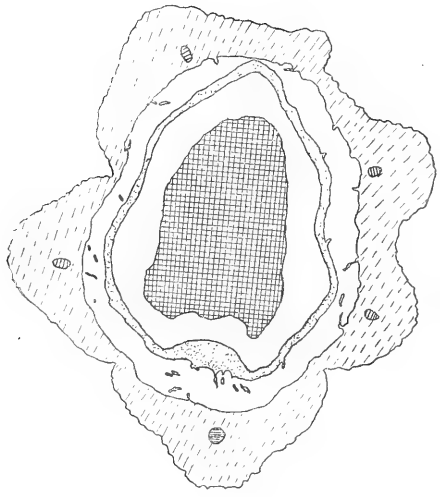


3 4

Figs. 3, 4. *Carpacoce spermacocea* × 122. For explanation see text.

ascertain the true nature of the parts which become differentiated in the fruit. In order to do this serial sections, 12 μ thick, were cut transversely through ovaries in various stages of development.

Figs. 3 and 4 depict transverse sections through a young ovary in which the ovule showed an early stage in embryo-sac development. The figures were drawn from sections cut at levels 1 and 5 respectively (see Fig. 2). In both figures the breaking down of the middle layer of the ovary wall is clearly seen, and as the inner layer ultimately becomes the wrinkled endocarp, its morphological nature is established without doubt. In Fig. 3 the inner layer shows a slight increase in thickness in



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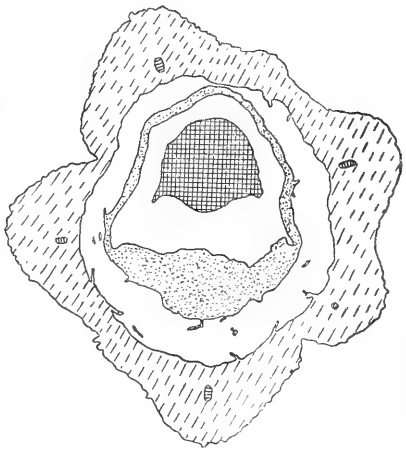

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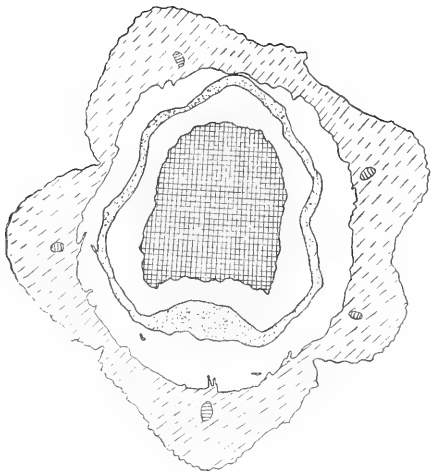

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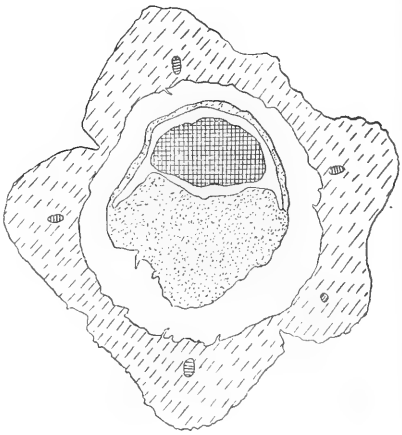

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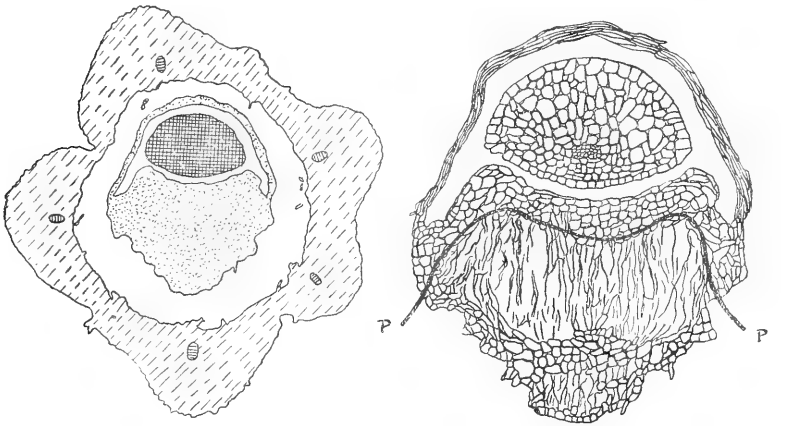
FIGS. 5, 6, 7, 8. *Carpacoce spermacocea* × 60. For explanation see text.

the lower part of the section. In Fig. 4 this wider portion is emphasised but it will be noted that the cells are all more or less alike.

The diagrams (Figs. 5—9) were made from sections of a much older ovary. Here the young seed showed a pro-embryo embedded in copious endosperm. These diagrams, taken in order, were made from sections cut at levels 1 to 5 as indicated in Fig. 2. The inner and outer layers of the ovary wall are quite separate though the remains of the broken down tissue of the middle layer are still evident. In Fig. 5 a slightly thickened portion of the inner layer is shown. This is more pronounced in Fig. 6 which was drawn at level 2, just where the tubercle is approached. In



9 10

FIGS. 9, 10. *Carpacoce spermacocea*. FIG. 9, × 60. Fig. 10, × 122. For explanation see text.

the remaining figures, taken at successively lower levels, the development of a much swollen region of the inner layer is depicted. This is the young tubercle which is a late development of part of the inner layer of the ovary wall. Fig. 10 is an enlarged and detailed drawing of the inner tissues shown diagrammatically in Fig. 9. It will be seen that the swelling of the tubercle is due to the enlargement of cells which are present in the earlier stage (Fig. 4).

In the ripe fruit a split in the tissues occurs as indicated by the line P—P (Fig. 10), so that finally the ripe seed is encased in tissues derived from part of the endocarp while the remainder of the endocarp goes to form the tubercle.

Before passing on to a discussion of these results, it should be noted that just where the style passes into the ovary a small cavity is often present, extending for a depth of about 0·1 mm. This cavity occupies a somewhat eccentric position and lies to one side of the vascular strand. Where the cavity itself is not present a small patch of deeply staining tissue occupies the same position. In this plant the main portion of the style shows no central hollow, but it is possible that the small cavity to which reference has been made, may be regarded as a reduced stylar cavity.

Discussion.

The foregoing account makes it quite clear that in this plant there is no obvious second carpel present. The unilateral swelling of the inner layer of the ovary wall (Fig. 4) may give a hint as to the position of a carpel which has all but disappeared in the course of evolution. It is, however, certain that the conspicuous tubercle of the fruit is a post-fertilisation development. Though it may have arisen as a secondary structure from the rudiment of the second carpel, it would be incorrect to speak of it as a reduced carpel.

Carpacoce vaginellata agrees so closely with *C. spermacocea* in all essential features of its ovary and fruit that there can be little doubt that its development proceeds in much the same manner as that described above.

As Captain Salter points out in his paper, there has been much confusion between *C. scabra* Thunb. and *C. vaginellata* Salter, which are very similar in vegetative features. It is possible that this similarity may have led Bentham and Hooker astray. Their statement that the ovary is two-chambered and has two ovules may have been based on an examination of *C. scabra*, and their description of the fruit may have been obtained from *C. vaginellata*. Unfortunately very little is known of *C. scabra* but it is certain that the ovary is correctly described as being two-chambered with one ovule in each. The subsequent development into a fruit which is said to separate into two portions suggests strongly that it is not closely related to *C. vaginellata* and *C. spermacocea* but would be more correctly placed in Anthospermum. With the removal of *C. scabra* the genus Carpacoce would be amenable to much more precise definition than is possible at present ; a definition based on good characters of ovary and fruit. However, fresh material of *C. scabra* is essential before its correct systematic position is established. Until such material is available, it must suffice to state that its position in Carpacoce is open to considerable doubt.

NOTES ON ALOE FEROX MILL., AND A. SUPRALAEVIS HAW., WITH A NEW NAME FOR A NATAL ALOE.

(With Plates 16—18.)

By G. W. Reynolds.

Berger (in Engler: Das Pflanzenreich, Liliac.-Asphodel.-Aloin. p. 310) records *A. ferox* Mill. from Ladysmith, Natal. He does not give any Cape locality for this species, with the result that many now regard certain Natal plants as belonging to *A. ferox* Mill., and certain smooth leaved plants in the Cape Province as being *A. supralaevis* Haw.

The purpose of this paper is to establish the true identity of *A. ferox* Mill. and *A. supralaevis* Haw., to prove that both species must have originated from the Cape *and are conspecific*, to show that the Cape and Natal plants are specifically distinct, and that Berger was therefore incorrect in naming the Natal species *A. ferox* Mill. which consequently must be renamed.

Miller's first description of *A. ferox* (in *Gard. Dict.* ed. 8. (1768) n. 22) is as follows :—

> "Aloe (*ferox*) foliis amplexicaulibus nigricantibus undique spinosis. *Aloe with dark green leaves embracing the stalks, which are beset with spines on every side.* Aloe vera costa spinosa. Munt. Phyt. Commonly called Aloe ferox."

In the subjoined notes Miller states "The twenty-second sort rises to the height of ten feet, with a strong stem, the leaves grow on the top, which closely embrace the stalk . . . They are of a green colour, and closely beset with short thick spines on every side. This sort has not yet flowered in England, nor does it put out suckers." He gives no locality of origin.

I have not succeeded in tracing a copy of *Muntingius' Phytographia* (1702) in South Africa, but in his *Aloidarium* 1680, fol. 23, an *Aloe vera costa spinosa* is figured. This certainly does not appear to belong to *Aloe*, and it seems that Miller was mistaken with his synonym. The plant figured by Muntingius bears little or no resemblance to the Cape *A. ferox*.

Lamarck (Lam. Encycl. 1. (1783), p. 87) referring to *A. ferox* Mill., gives only one synonym, *i.e.* Comm. Prael. 70. t.19. Haworth in *Trans. Linn. Soc.* VII (1804) p. 22 cites Mill. Dict. n.22, but excludes Muntingius'

synonym ; he cites " *Comm. Pr.* t.19," and adds " This is the loftiest of the Aloes ; I have seen it near 20 feet high. It is also the roughest leaved."

As regards Commelin's *Praeludia Botanica* (1703) p. 70, fig. 19, which the author describes as " *Aloe Africana caulescens, foliis glaucis caulem amplectentibus latioribus and undiquaque spinosis,*" this is cited in the synonymy of *A. ferox* Mill. by the following workers : De Candolle in *Plant. Grass.* (1799) t.32, Simms in *Bot. Mag.* (1818) t.1975, and Baker in *Journ. Linn. Soc.* XVIII (1880) 179. This proves fairly conclusively that Commelin published the first representation of the species and not Muntingius.

De Candolle (l.c.) also cites Miller's synonym *Munt. Phyt.* p. 20, f. 95, previously discussed, and in addition he cites *Munt. Aloid.* p. 16, f. 17, but this is an obvious error. Muntingius in his *Aloidarium* 1680 (which is added to his *Herba Britannica* 1681) does publish an " *Aloe ferox,*" fol. 17, but the plant illustrated without flowers is certainly not an *Aloe* and must belong either to *Agave* or an allied genus.

When dealing with Commelin's figures of *Aloe*, it is important to bear in mind that the first sentence of the text dealing with his first *Aloe* (that is, p .68, fig. 17) reads as follows :—

> " Anno millesimo septingentesimo semina a Strenuissimo Promontorii Bonae Spei Gubernatore Wilhelmo Adriano vander Stel missa hanc & quinqui sequentes Aloes species produxerunt."

The first six *Aloe* figures are Nos. 17, 18, 19, 20, 21, and 22, hence, *A. ferox* (fig. 19) was one of the species raised from seed sent to Holland by Wilhelm Adrian van der Stel in 1700, and figured when very young.

Some of the earliest publications give no locality of origin for *A. ferox*, but Haworth (l.c.) records it from *Caput Bonae Spei*, while Aiton in *Hort. Kew.* vol. II (1811) p.293 says that the " Great Hedgehog Aloe " is a native of the Cape of Good Hope, cultivated by Miller in 1750. Simms (l.c.) has the same information except that he gives the date of cultivation by Miller as 1759. From all the evidence, *A. ferox* unquestionably came from the Cape, a very probable locality being the Swellendam district, which is its nearest habitat to Cape Town, and where the earliest botanical collectors would most likely first have discovered it.

Judging by the various descriptions, *A. ferox* is characterised by a stem up to 20 feet, *leaves spiny on both surfaces*, a candelabra-like inflorescence bearing erect racemes with flowers evenly distributed around the axis. No mention is made of *sub-erect* or *oblique* racenes ; this is a character of the Natal species to which further reference is made later.

As regards *A. supralaevis* Haw. (*Trans. Linn. Soc.* VII. 1804 p. 21), this species was also founded on leaf characters only, the first publication reading :—

FIG. 1.

FIG. 2.

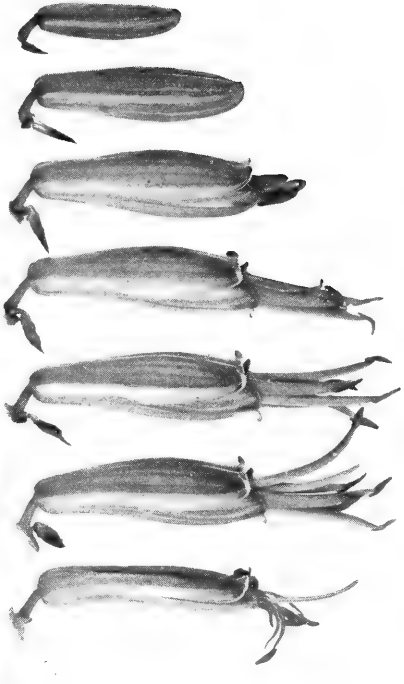


FIG. 3.

PLATE 17. *Aloe ferox* Mill., var. *Galpini* (Bak) Reynolds.
FIG. 1. Plant fl. 31 August, 1936, rocky slopes near Bongolo Dam, Queenstown.
FIG. 2. Plant in natural habitat on hills near Bailey, about 10 miles N.W. of Queenstown, fl. 31 August, 1936.
FIG. 3. Flowers natural size, from bud to post-pollination stage.

70 C. COMMELIN PLANTARUM

Aloe Africana caulescens, foliis glaucis caulem amplectentibus latioribus & undique spinosis.

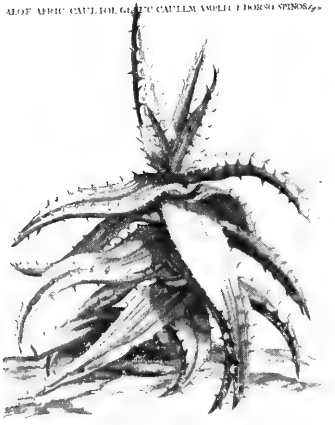
RAdices hujus Aloes tenues sunt & copiosæ. Tota planta nunc temporis sesqui pedis altitudinem superat, & caule sustentatur rotundo, fusco & tribus unciis crassiore, huic folia adnascuntur crassa, glauca & rigidissima, quæ pedis longitudinem, & quatuor unciarum latitudinem habent, in mucronem spinosum exeunt, & ab utraque sui parte & margine spinis armantur rigidissimis & acutissimis.

Hujus plantæ succus flavescit, fœtet & maxime amaricat.

Aloe

ALOE AFRIC CAULESC FOL GLAUC CAULEM AMPLECT SPINOS

FIG. 1.



RARIOR: & EXOTIC ICONES & DESCR

Aloe Africana caulescens, foliis glaucis caulem amplectentibus, dorso integro spinoso.

MUltiplici & fibrosa radice nutritur hæc Aloe pedem altior, caule sustentatur duabus unciis crassior, cui folia adnascuntur pedem longa, duas uncias cum media lata, quæ in mucronem terminantur acutum & spinosum, ac in utroque latere & dorso integro spinis armantur multis & rigidissimis; circa foliorum initium, ubi caulem amplectuntur, venæ in hac & præcedente apparent viridis in ipsa folia evanescentes.

Succus hujus plantæ fœtet, amaricat & flavescit.

In quatuor hisce jam descriptis Aloes speciebus hoc notandum, quod si illæ per ætatem in hypocaustis vitreis conserventur, spinas, quibus armantur, cum viriditate quadam albescere, si vero aeri liberiori exponantur, spinas omnes rubras evadere.

I 3 Alo-

FIG. 2.

PLATE 16.

FIG. 1. Commelin: *Praeludia Botanica* (1703), p. 70, fig. 19, regarded as representing *Aloe ferox* Mill.

FIG. 2. Comm. (l.c.), p. 71, fig. 20, considered to be *A. supralaevis* Haw.

"A. supralaevis. Aloe foliis oblongo-ensiformibus rigidis glaucescentibus ; supra laevibus, infra irregulariter spinosis."

It will be noted that in Haworth's type only the upper surface is smooth, the lower being "irregularly spiny," while no locality is given. In his second publication (*Syn. pl. succ.* 1812. p. 76) Haworth merely adds "*Caule fruticoso simplici*" and records the "Upright Hedgehog Aloe" from *Caput Bonae Spei*. In the synonymy he gives Comm. Hort. Amst. (1701) fig. 13, (which is *Aloe africana foliis glaucis, margine et dorso integro spinosis*), and Comm. Prael. bot. (1703) fig. 20,—which is *Aloe Africana caulescens, foliis glaucis caulem amplectentibus, dorso integro spinoso*. Fig. 13 in *Hort. Amst.* II, illustrates a very young plant with few very weak spines, and might represent *A. ferox*. As regards fig. 20 in *Prael. Bot.*, this is also one of the six species raised from seed sent to Amsterdam in 1700 by Governor van der Stel, and as such, also most probably came from Swellendam or a neighbouring district.

I have photographed Commelin's figs. 19 and 20, and reproduce them herein (Plate 16). From a study of these interesting figures, it will be seen that there is scarcely any difference between them, and certainly not sufficient to suggest that they are specifically distinct.

Aiton in *Hort. Kew.* vol. II (1811) p. 293 cites Comm. prael. 71. t.20 in synonymy under *A. supralaevis* Haw., and records "Upright Hedgehog Aloe, native of the Cape of Good Hope. Cult. 1731 by Mr. Ph. Miller." Subsequent accounts of *A. supralaevis* contain nothing to suggest that *A. ferox* and *A. supralaevis* are specifically distinct, except that the leaf of the former is spiny both sides, and in the latter smooth above. Both are "Hedgehog Aloes," both are figured by Commelin, both were raised from seeds sent at the same time and from localities which could not have been far from Swellendam, which all points to their being conspecific.

What do we find near Swellendam to-day ? Are there two distinct species, or are there merely forms of one variable species ? I have not had an opportunity of examining plants as far west as Swellendam, but Dr. John Muir. of Riversdale, assures me that in the Riversdale and Swellendam districts *A. ferox* occurs with leaves spiny both sides ; in some the leaves are less spiny, with intermediate degrees of spininess in others, but in all cases the inflorescence bears erect densely flowered cylindric-acuminate racemes, with flowers evenly distributed. The floral characters are remarkably uniform, and the degree of spininess of the leaves is not of specific importance.

Marloth (in *S.A. Gardening*, Nov. 1929, p. 354) in his description of *A. Tomlinsonii* (which he describes as a natural cross between *A. ferox* Mill. and *A. speciosa* Bak., from the Breede river valley near Swellendam),

refers to an *A. ferox* var. *supralaevis.* and observes "*A. supralaevis* is not specifically distinct from the ordinary type of *A. ferox.*" I cannot trace a description of this variety in any earlier publication, while no description is given in *S.A. Gardening*, his only reference to var. *supralaevis* being the observation "There is . . . not one plant to be seen which seriously deviates from the type of *A. ferox* var. *supralaevis.*" Again in *Bothalia*, Vol. III, Part I, Aug. 1930, p. 143, Marloth states "Having recently . . . to study . . . hybrids between *A. ferox* var. *supralaevis* and *A. speciosa* Bak. . . . " It will be noted that in *S.A. Gard.* Marloth gives the one parent as being *A. ferox*, while in *Bothalia* it is *A. ferox* var. *supralaevis.* In the National Herbarium. Pretoria, there are two sheets labelled *A. ferox* Mill. var. *supralaevis* (author not stated) namely, Marloth 13690 ! near Napkysmond, bank of Breede River, July 1929, and Marloth without number ! Swellendam Dist. 12/8/29. It seems that Marloth mentioned the var. *supralaevis* merely in observations, and that the varietal name has had no valid publication and should, it appears, be dropped.

A. ferox Mill. in its various forms extends from Swellendam through the coastal and midland districts of the Eastern Cape Province to the Orange Free State, where it is found in the south-eastern corner of the Rouxville district, and along the valley of the Orange river from Aliwal North into southern Basutoland. It is also found in abundance near Queenstown, in tremendous quantities on the hills of the Kei river valley, and beyond Umtata into Pondoland. In these latter areas, plants are found mostly with leaves smooth both sides save for a few spines in median line dorsally near apex ; they do not agree with Haworth's description of *A. supralaevis* which is "irregularly spiny below," and appear to differ sufficiently from the typical spiny form to merit varietal rank.

In *A. ferox* we have an example of a species grading through intermediates from one form to another. The typical form grades into the varietal form. From Swellendam eastwards there is a gradual transition from leaves spiny on both sides to leaves smooth on both sides, from brownish to reddish marginal teeth, and from shorter to longer racemes. The flowering period appears to vary according to altitude and climatic conditions. Along the coastal belt plants flower in May—June, further inland (Queenstown) in July—August, Tarkastad in September, while from Aliwal North into Basutoland they flower in November. *A. Galpini* Bak. (1901) from Queenstown, will be referred to later

As regards *A. supralaevis* var. *erythrocarpa* Berger (l.c.) 309, this is described with leaves smooth both sides, rarely aculeate below, with red marginal teeth . . . , of unknown origin cultivated at La Mortola,

localities cited being Riversdale, Graaff-Reinet, Uitenhage, Grahamstown and Queenstown. As has been pointed out already, the more eastern plants are less spiny or spineless forms of the species at Swellendam.

Therefore, from the date of its introduction into European gardens (1700), from the various published accounts, and from the knowledge of the plants found in South Africa to-day, it follows that *A. supralaevis* Haw. cannot be upheld as a distinct species, and must go into synonymy under *A. ferox* Mill. as a form with leaves less spiny than the typical. A. *supralaevis* Haw. var. *erythrocarpa* Berg. must be referred to *A. ferox* Mill. var. *Galpini* (Bak.) Reynolds hereunder described.

Aloe ferox Mill var. **Galpini** (Bak.) Reynolds.—*A. Galpini* Bak. in Kew Bull. (1901) 135; *A. supralaevis* Haw. var. *erythrocarpa* Berger (l.c.) 309.—Comb. nov., a forma typico foliis laevibus, dentibus rubris differt.

Hab. Cape Province: Kopjes near Klaas Smits River, Queenstown, Aug. 1897, Galpin 2335!: Hills near Queenstown, fl. 31 Aug. 1936, Reynolds 2078! (type); Kloof of the Windvogelberg, Cathcart, fl. 28 Aug. 1936, Reynolds 2075! Transkei: near Komgha, Sept. 1892, Flanagan 1327!; Kentani Dist. July 1913, Alice Pegler 1201!; Kei Hills near Zig-zag, 23 June 1935, Reynolds 1416!; Hills near Cala, 16 Aug. 1936, Reynolds 2049!. Basutoland: Quthing Dist.: Nov. 1913, Dieterlen 943!. "Sesotho name—Lekhala le lekolo." All in Nat. Herb. Pretoria. (Plate 17.)

Description.—Plant succulent, with stem 3—5 met. high, simple, rarely forked or branched, usually densely covered with the remains of old dry leaves. *Leaves* 50—60 in a dense capitate rosette, lanceolate-ensiform, up to 1 met. long, 15 cm. broad at base, dull green, sometimes reddish tinged; upper surface slightly canaliculate, smooth; lower surface convex, smooth save for a few reddish spines in median line near apex; margins sinuate-dentate armed with reddish teeth about 6 mm. long, 10—20 mm. distant. *Inflorescence* one only, a branched panicle with 5—10 erect racemes. *Racemes* erect, unicoloured reddish to orange, cylindric slightly acuminate, very densely multi-flowered, 50—80 cm. long, 9—12 cm. diam. at base, about 6 cm. diam. at apex, the buds horizontally disposed and slightly laxer than the open flowers, the flowers first opening up the side facing the sun. *Pedicels* green, 4—5 mm. long. *Bracts* ovate-acute, 8—10 mm. long, 3—5 mm. broad, thin scarious brownish, 3—5-nerved. *Perianth* scarlet to orange, clavate-cylindric, slightly ventricose, varying from 28 mm. to 40 mm. long, about 33 mm. the average. *Outer segments* free for about two-thirds their length, ob-

scurely 3—5-nerved, the nerves reddish-orange, the apices subacute spreading. *Inner segments* free but dorsally adnate to the outer for one-third their length, with thin whitish margins, carinate with 3 congested nerves, the middle nerve usually more raised than the other two, the colour of the perianth, turning green at apex, the apices spreading to revolute, light to deep brown tipped. *Filaments* flattened, the 3 inner narrower and lengthening in advance of the 3 outer, the included part lemon, the exserted part (20 m.m) orange to brownish-orange eventually turning deep brown to black. *Anthers* the 3 inner and 3 outer in turn exserted 20—25 mm. *Stigma* exserted 20—25 mm., with the exserted portion of the style slightly lighter in colour than the filaments. *Ovary* 6—7 mm. long, 4 mm. diam., finely 6-grooved, green.

In his description of *A. Galpini*, Baker (l.c.) records " Cape Colony : mountain sides, Queenstown, alt. 3,500—4,000 ft., Galpin 2335." Fortunately, Galpin 2335 ! is in Nat. Herb. Pretoria. Berger (l.c.) 309 places *A. Galpini* in synonymy under *A. supralaevis* Haw., but the latter should now be referred to *A. ferox* Mill. *A. Galpini* cannot be upheld as a distinct species, but since the Queenstown etc. plants well merit varietal rank, *A. Galpini* may now correctly be referred to a variety to *A. ferox* Mill., with *A. supralaevis* Haw., var. *erythrocarpa* Berg. in synonymy. In order to observe the Rules of Nomenclature, Baker's spelling of the name is retained.

To recapitulate, the typical form of *A. ferox* is that in which the leaves are copiously spiny on both surfaces, the spines and marginal teeth brownish, the inflorescence (one only) bearing *erect* racemes with the flowers evenly distributed round the axis. This form is found in the stations furthest west for the species, namely the Swellendam and Riversdale districts of the Western Province ; but it is *not* the form most typical of the species as a whole throughout its 550 miles distribution from Swellendam to Basutoland and Pondoland. The greatest numbers occur with smooth leaves. I have chosen Queenstown and the Kei Hills as typical localities for the var. *Galpini* which is characterised by having smooth leaves, except sometimes for a few reddish spines dorsally near apex, reddish marginal teeth, and longer racemes sometimes reaching 80 cm. in length. The stem is mostly simple and covered with the remains of old dry leaves ; in the Kat river valley near Seymour (Stockenstroom Div.) a few specimens may be seen branched high up into six crowns, but this is unusual. In the Queenstown district I have found an occasional plant with racemes shaped like cricket bats or tennis racquets, due to fasciation, while I have also seen one plant with one of its racemes tripartite at the apex. I cannot recall ever having noticed any plant with more than one inflorescence ; usually there are 5—10 erect

racemes, the racemes being longer than their branches, compactly grouped, with the whole inflorescence rather corymbose. Berger (l.c.) 308 figures *A. supralaevis* (now referred to *A. ferox* Mill.) with an inflorescence showing the terminal raceme standing out higher than the others ; this is not typical of *A. ferox*. In *A. candelabrum* Berger, so plentiful in the Umlaas and Umkomaas valleys in Natal, the terminal raceme is usually higher than the others, but *A. candelabrum* is readily distinguished by its more recurved leaves, the outer segments of the perianth greenish-nerved with the apices of the inner segments *white* ; in *A. ferox* and the var. *Galpini*, the nerves of the outer segments are reddish-orange, with the apices of the inner segments light to dark *brown*.

Space does not permit of a detailed discussion on natural hybrids, but it can be stated with reasonable certainty that *A. ferox* (or the var.) crosses with the following species :

A. africana Mill., plentiful in Albany and Uitenhage districts.
A. arborescens Mill. (=*A. SalmDyckiana*) Mossel Bay, Riversdale.
A. Broomii Schonl., near Aliwal North and Lady Grey.
A. microstigma Salm Dyck, Fort Brown, Carlisle Bridge, Albany Div., Bruintjes Hoogte near Somerset East.
A. pluridens Haw., Bedford Dist.
A. saponaria (Ait.) Haw., Umtata, Transkei
A. spicata Linn. f. (=*A. Tomlinsonii*, Marloth.) Swellendam Dist. ; Kirkwood, Fort Brown, Albany Div.
A. striata Haw. Hell Poort near Grahamstown

Note : As regards the reference to *A. spicata* Linn. fil., Marloth in *Bothalia* 1930, gives full reasons why *A. speciosa* Bak. should go into synonymy under *A. spicata*, Linn. f.

Aloe spectabilis Reynolds.—*A. ferox* Berger non Miller (l.c.) 310 ; *A. ferox* Berger non Miller var. *xanthostachys* Berger (l.c.) 310. Nom. nov. Affinis *A. Marlothii* Berger, sed racemis suberectis brevioribus differt. *A. ferox* Mill. (non Berger) planta tota diversa est.

Hab : Natal : Tugela river valley between Greytown and Helpmakaar, fl. 28 July, 1936, Reynolds 2033 ! (type) ; Mooi river valley near Keats Drift, fl. 28 July, 1936, Reynolds 2034 ! ; near Muden, fl. 28 July. 1936, Reynolds 2031 ! ; in the Biggarsberg near Waschbank, fl. 2 June 1935, Reynolds 1394 ! All in Nat. Herb. Pretoria. (Plate No. 18.)

Description. Plant succulent with simple stem 2—4 met. high. rarely forked high up, densely covered with the remains of old dry leaves. *Leaves* about 50, densely rosulate, lanceolate-ensiform, dull green, sometimes reddish tinged, about 1 met. long, 12—15 cm. broad at base ;

upper surface slightly concave, usually copiously spiny ; lower surface convex, copiously spiny throughout ; margins sinuate-dentate, armed with stout deltoid pungent teeth 5—7 mm. long, 10—20 mm. distant, varying in colour from reddish to brownish. *Inflorescence* a branched panicle, 1—3 from a rosette, each with up to 14 racemes. *Peduncle* very stout, flattened low down, brown, somewhat sulcate, sometimes bearing a few thorns, the lowest branches usually 2—3 branched. *Racemes* erect or sub-erect, rather truncate, mostly 25 cm. long, 9—10 cm. diam., densely multi-flowered, the buds and flowers more or less horizontally disposed, more evenly distributed in upper portion, slightly sub-secund below, the buds slightly redder than the yellow to golden yellow open flowers. *Bracts* ovate-acute, thin scarious, deep brown, reflexed, 4—5 mm. long, 5 mm. broad at base, 3—5-nerved. *Pedicels* 3 mm. long. *Perianth* yellow to golden-yellow, rather narrowly clavate-cylindric, 32 mm. long, about 5 mm. diam. at base, slightly decurved and enlarging to about 8 mm. diam. at throat. *Outer segments* free to the middle or beyond, faintly 3—5 greenish nerved, the 2 uppermost more closely grouped, with their apices somewhat falcately connivent. *Inner segments* free but dorsally adnate to the outer for one-third their length, broader than the outer, carinate with 3 congested yellowish nerves in median line, the margins pale lemon almost white, the apices more obtuse than the outer, with the revolute part dull to glossy deep purplish-black to black, and with the apical 5 mm. of the margins sometimes similarly coloured. *Filaments* flattened, the 3 inner narrower and lengthening in advance of the three outer, pale lemon within the perianth, the exserted part (20 mm.) orange. *Anthers* exserted 20 mm. *Style* lemon coloured within the perianth, the exserted part paler orange than that of the filaments, with the stigma at length exserted 20 mm. *Ovary* 7 mm. long, 3·5 mm. diam., finely 6-grooved, green.

Although also found elsewhere in Natal, the form most typical of the species occurs in large numbers in the Bushmans River valley near Weenen, along the Mooi River near Muden and Keats Drift, and especially in the valley of the Tugela River between Mpofana and Pomeroy on the Greytown—Dundee road. It is a very different species from *A. ferox* Mill. of the Cape, and Berger is incorrect in referring the Natal plants to Miller's species. Apart from the reasons already given, it should be remembered that *A. ferox* Mill. was in cultivation at a time (1700—1750) when, botanically speaking, Natal was a *terra incognita*. It follows that the Natal plants must be given a new name, and the name *A. ferox* Berger non Miller put into synonymy. On the other hand, the various publications and synonyms cited by Berger (l.c. 310) under *A. ferox* are correctly placed under *A. ferox* Mill. Berger's description of *A. ferox*

FIG. 1.

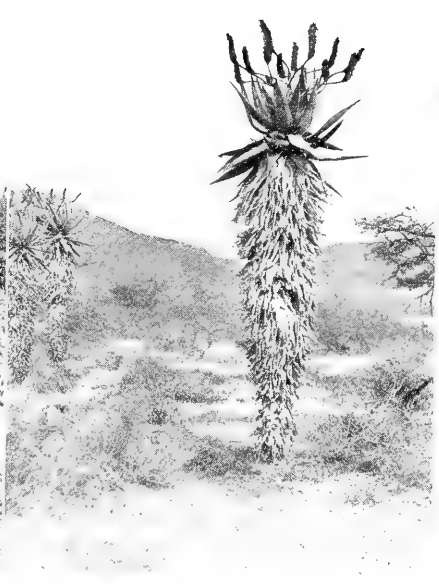


FIG. 2.

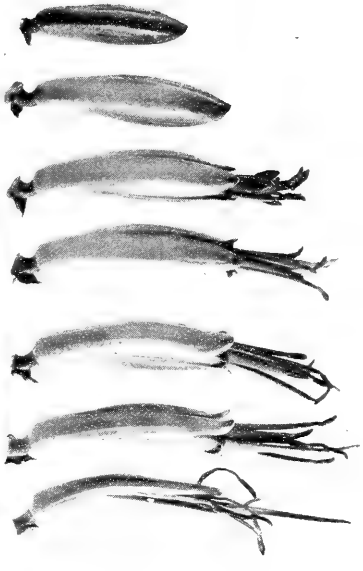


FIG. 3.

PLATE 18. *Aloe spectabilis* Reynolds.

FIG. 1. Plant with 3 inflorescences (33 racemes), fl. 2 July, 1934, in the valley of the Bushman's River, near Weenen, Natal.
FIG. 2. Plant with 1 inflorescence bearing 12 racemes, fl. 28 July, 1936, in the Mooi River valley, near Muden, height 12 feet.
FIG. 3. Flowers natural size, from a plant fl. 28 July, 1936, in the Tugela valley, between Greytown and Helpmakaar.

and his fig. 131, although not identical with my *A. spectabilis*, no doubt represent a cultivated form of this species.

The Natal species is much more closely related to *A. Marlothii* Berger than to *A. ferox* Mill. Berger (l.c. 312) cites Lobatsi and Johannesburg for typical *A. Marlothii*; in these localities and throughout the hilly parts of the Transvaal, *A. Marlothii* bears longer narrower almost horizontal racemes with flowers very markedly secund, while in *A. spectabilis* the racemes are shorter and broader, more truncate and almost erect, with the flowers much more evenly distributed round the axis. Another important difference is that in *A. Marlothii* the apices of the inner segments and the exserted part of the filaments are light to deep *purple*, while in *A. spectabilis* the exserted part of the filaments is *orange*, and the apices of the inner segments dull to deep glossy ***black***. In some flowers it almost looks as if an artist had tipped the apices with glossy black enamel. This shows up fairly clearly in the second flower from the bottom in the accompanying figure.

A difficulty arises concerning plants further north-east in Zululand. Attention has already been drawn (This *Journal*, Jan., 1937) to certain species in the section *Saponariae* grading through intermediates from one to another; the same thing happens with *A. spectabilis* and *A. Marlothii*. The Natal plants with shorter broader sub-erect racemes certainly appear specifically distinct from *A. Marlothii*. In the White Umfolozi valley, Zululand, plants occur with longer narrower subhorizontal racemes and secund flowers so characteristic of *A. Marlothii*, but with orange (not purple) stamens. In the Black Umfolozi valley the stamens are more brownish-orange, while along the Lebombo range (Eastern boundary of Swaziland), they are mostly yellow to yellowish-orange. It seems that these plants must be regarded as being either yellow or orange stamened forms of *A. Marlothii*, or intermediates nearer *A. Marlothii*.

It will therefore be seen that from Natal through Zululand and Swaziland to the Transvaal and Bechuanaland, *A. spectabilis* grades into *A. Marlothii*. There is a gradual change from sub-erect to horizontal racemes, shorter (25 cm.) more truncate racemes to longer (30—35 cm.) narrower racemes with secund flowers, from yellow-orange to purple stamens, and from glossy black to dull purple inner segment apices. It might be advisable to record that *A. spectabilis* does not grade into *A. ferox*. In the country intervening between these two species, (*i.e.* south of Weenen and north-east of Pondoland) *A. candelabrum* is found, with *A. Thraskii* Bak. growing only along the beaches, especially between Durban and Port Shepstone.

Another name to be considered is *A. sigmoidea* Bak. (in *Journ. Linn.*

Soc. XVIII, 1880, 177) recorded from Amatongaland, collected by Cooper, and described from a young plant without flowers. If the Amatongaland of Baker is the country known by that name today, *i.e.* east of the Lebombo range in north-eastern Zululand, then, from Baker's description and the knowledge of the plants found in that area today, it seems that A. *sigmoidea* might be the yellow stamened form of *A. Marlothii*, or perhaps a cross of *A. Marlothii* with either *A. arborescens* Mill. or *A. sessiliflora* Pole Evans, the last mentioned not being scarce along the Lebombo range.

As regards natural hybrids of *A. spectabilis*, I have been informed of others, but have only personally noticed crosses with *A. arborescens* Mill. in the Biggarsberg South of Dundee, and with *A. nitens* Bak. near Muden.

In an article on "*A. Marlothii*, some Forms and Hybrids" published in the *Journal of the Botanical Society of S. Africa*, 1935, I fear I followed Berger—not without hesitation—and referred to the Natal plants as being *A. ferox*. This was a mistake. If *A. spectabilis* is substituted for *A. ferox*, that article will now read correctly.

I wish to express my sincerest thanks to Dr. I. B. Pole Evans, C.M.G., Chief of the Division of Plant Industry, Pretoria, for his great kindness in affording me access to the Division's Library and for permission to photograph the text and figures of many of the earliest works; to Dr. E. P. Phillips, Principal Botanist, Dr. R. A. Dyer, Miss M. Gunn, Librarian, and Miss I. C. Verdoorn, Botanist, for assistance in collecting data; to Dr. H. G. Schweickerdt, at Kew, for copying the *Aloes* in Miller's Dictionary, ed. 6, and to Mrs. M. Moss, Witwatersrand University, for kindly affording me an opportunity of consulting and photographing the *Aloes* in *Miller's Dictionary*, ed. 8, and *Lamarck's Encyclopaedia*, 1783.

TWO NEW ALOES FROM ZULULAND AND TWO FROM THE TRANSVAAL.

(With Plates 19—22.)

By G. W. Reynolds.

A further step forward towards the clearing up of our South African *Aloes* is contributed in the present paper, two new species being described from Zululand, and two from the Transvaal.

Aloe Gerstneri, Reynolds. Species nova, *A. petricolae* Pole Evans et *A. aculeatae* Pole Evans affinis. *Planta* succulenta, acaulescens vel breviter caulescens. *Folia* 20—30, dense rosulata, arcuato-erecta, lanceolato-ensiformia, usque ad 60 cm. longa, 9 cm. lata ; supra planiuscula, subtus convexa, utrinque glauco-viridia, immaculata, laevia ; marginibus dentibus brunneis isolatis 4—5 mm. longis, 10—15 mm. distantibus armata. *Inflorescentia* usque ad 1.3 met. alta, 1—2-ramosa. *Racemi* cylindrico-acuminati, usque ad 36 cm. longi, 6—7 cm. diam. *Pedicelli* 5 mm. longi. *Bracteae* anguste lanceolatae, scariosae, 18 mm. longae, 5 mm. latae. *Perigonium* 30 mm. longum, cylindrico-ventricosum, leviter clavatum. *Segmenta exteriora* per 15—17 mm. libera, obscure 5-nervata ; interiora nervis tribus congestis carinata. *Genitalia* 13 mm. exserta. *Ovarium* 5 mm. longum, 3 mm. diam.

Hab. Zululand : on rocky banks of the Nondweni River at Barkliside 31 miles south of Vryheid, alt. 3,000 ft. approx., fl. 6 March, 1937, Reynolds 2,320 ! (type) in National Herbarium, Pretoria, also in Bolus Herb., Kirstenbosch. (Plate 19.)

This new *Aloe* was collected by Rev. F. J. Gerstner about 5 years ago and sent to Kirstenbosch. It was first brought to my notice by Mr. N. S. Pillans, who suggested that I should investigate the species and name it in honour of Rev. Gerstner who has contributed a large amount of material to various Herbaria, and who is at present compiling a Flora of Zululand. Rev. Gerstner kindly imformed me of the locality where he had collected this *Aloe,* and a special journey was made to Zululand during June, 1936, but it was found that plants had flowered a few months previously, the scapes being very dry. On that occasion, plants were collected and sent to Kirstenbosch (No. 1554/36) and to the Botanical Section, Division of Plant Industry, Pretoria (No. 1396/7/36). During

February, 1937, a large specimen in my garden in Johannesburg showed signs of flowering, and on 6 March another special journey was made to Barklieside, when a few hundred plants were found in full bloom, photographs secured, the description drawn up, and material sent to the National Herb. and Bolus Herb.

A. Gerstneri is found in fairly large numbers on rocky slopes and outcrops on both sides of the Nondweni River at Barklieside (also known as Nondweni Bridge), 31 miles south of Vryheid on the road to Melmoth, where it flowers during February-March. Mr. J. F. de Wet, Vryheid, records that the real home of *A. Gerstneri* is not at Barklieside, but about 14 miles further on along the Babanango road and eastwards of it, on the granite koppies scattered along the course of the Intintini spruit, a tributary of the White Umfolozi. Mr. de Wet adds, "On the granite formation they grow into much finer bigger plants than the Nondweni quartz. Most of the inflorescences of mature plants have three branches, many plants with two inflorescences bearing six racemes in all." In general habit of growth, leaf, inflorescence, and shape and size of flowers it seems nearest allied to *A. petricola* Pole Evans, found principally in the Nelspruit and Sabie Districts of the Eastern Transvaal, but the latter flowers during June-July, and has more glaucous, more leathery, more spreading, straighter leaves, shorter pedicels, bicoloured racemes, and flowers more clearly nerved. (*Vide Trans. Roy. Soc. S.Af.*, Part 6, 1917, Plate LIV). Another near ally is *A. aculeata* Pole Evans, which grows further north in the Lydenburg, Waterberg, Pietersburg and Zoutpansberg Districts of the Transvaal, and as far north as 80 miles south of Salisbury in S. Rhodesia, but this species, which also flowers in June-July, is immediately separated by its very aculeate leaves and larger flowers. (*Vide Trans. Roy. Soc. S.Af.*, Vol. V., Part I, June, 1915, Plates XIV—XV.)

A noteworthy character of *A. Gerstneri* is the very distinct white base from which the marginal teeth spring. This is a character not found in *A. petricola*, but it occurs in the Zoutpansberg form of *A. aculeata*. In young plants of *A. Gerstneri*, the leaves are usually copiously spiny on both sides, sometimes with a row of spines down the median line dorsally; these spines disappear with age until in mature specimens the leaves are smooth both sides, except sometimes for a few in median line dorsally near apex.

Description.—Plant succulent, acaulescent or shortly caulescent, the stem simple or rarely branched. *Leaves* 20—30 densely rosulate, arcuate-erect, lanceolate-ensiform, up to 60 cm. long, 9 cm. broad at base; upper surface dull grey-green, flat or slightly concave, immaculate smooth; lower surface convex, immaculate, smooth except sometimes

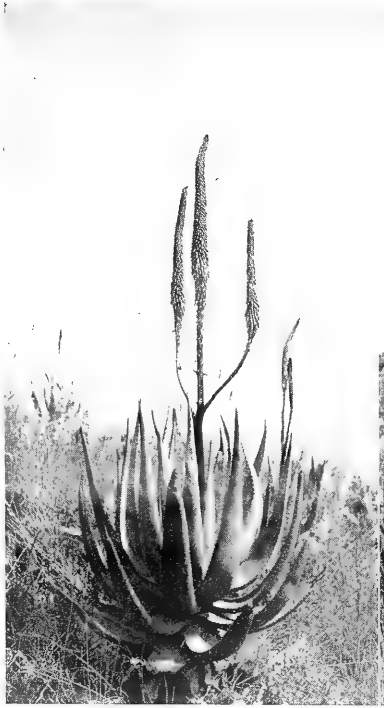


FIG. 1.

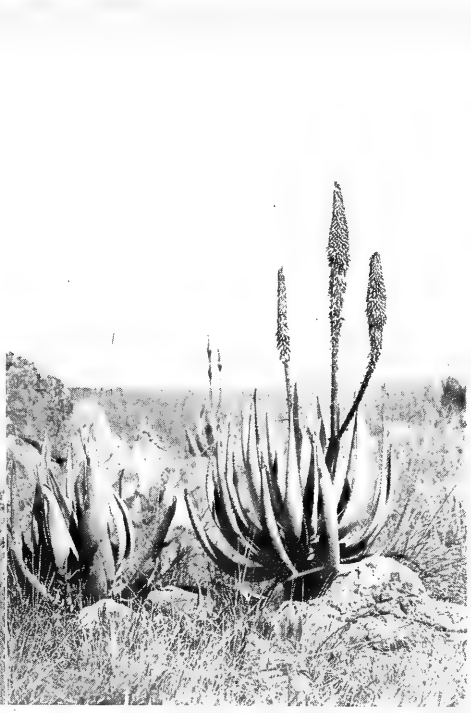


FIG. 2.

FIG. 3.

PLATE 19. *Aloe Gerstneri* Reynolds.

FIGS. 1-2. Plants in natural habitat at Barklieside, 31 miles south of Vryheid, Zululand, fl. 6 March, 1937. (*Note.*—Fig. 1 represents a typical specimen ; Fig. 2 is of a smaller plant with one simple and one forked inflorescence, the racemes shorter than usual.)

FIG. 3. Flowers 1/1, from bud to post-pollination stage.

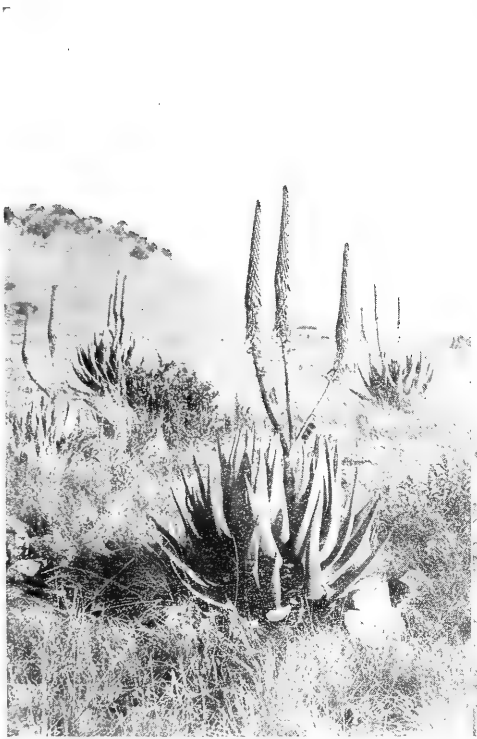


FIG. 1.

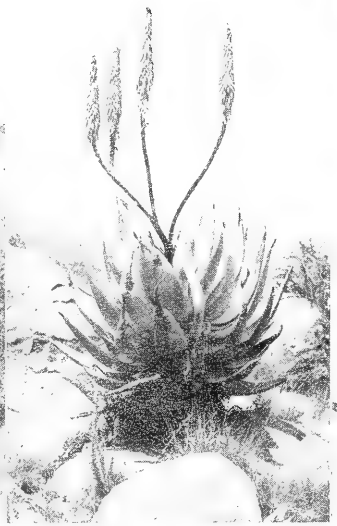


FIG. 2.

FIG. 3.

PLATE 20. *Aloe Reitzii* Reynolds.

FIG. 1. Plants in natural habitat at Suikerboskop, 13 miles north-west of Belfast, Eastern Transvaal, fl. 4 March, 1937.
FIG. 2. Plant in natural habitat near Tonteldoos, about 16 miles north-west of Dullstroom, Eastern Transvaal, fl. 28 Feb., 1937.
FIG. 3. Flowers natural size from bud to fruit stage. (*Note.*—Flowers are scarlet above, yellow to lemon underneath.)

for a few thorns in median line near apex ; margins armed with isolated pale brown teeth springing from a white base, the teeth pungent, deltoid, 4—5 mm. long, 10—15 mm. distant, more crowded low down, more distant near apex, the interspaces straight, the colour of the leaf. *Inflorescence* up to 1 ·3 met. high, simple in young plants, or with 1—2 branches in mature specimens, occasionally 2 from a rosette. *Peduncle* flattened low down and up to 4 cm. diam., clothed below the racemes with numerous thin, scarious, brown, many-nerved sterile bracts up to 20 mm. long, 8 mm. broad at base. *Racemes* densely multi-flowered, cylindric slightly acuminate, up to 36 cm. long, 6—7 cm. diam. *Bracts* narrowly lanceolate, brown, thin, scarious, many-nerved, 18 mm. long, 5 mm. broad at base. *Pedicels* green, 5 mm. long. *Perianth* 30 mm. long, reddish-orange, slightly paler underneath, cylindric-ventricose slightly clavate, very shortly stipitate at base and slightly tapering into the pedicel, the mouth slightly upturned. *Outer segments* free for 15—17 mm., obscurely 5-nerved turning brownish at apex, the margins paler, the apices sub-acute, the 2 upper more closely grouped with their apices slightly falcately connivent. *Inner segments* free but dorsally adnate to the outer for 10 mm., the upper segment with 3 congested nerves forming a reddish keel, the 2 lower segments with 3 crowded nerves forming a greenish keel turning brownish at apex. *Filaments* flattened, the 3 inner narrower and lengthening in advance of the 3 outer, pale lemon within the perianth, the exserted portion brownish. *Anthers* the 3 inner and 3 outer in turn exserted up to 13 mm. *Style* filiform, pale lemon throughout, the exserted part not changing colour. *Stigma* at length exserted up to 14 mm. *Ovary* pale green, 5 mm. long, 3 mm. diam. at base, finely 6-grooved.

Aloe Reitzii, Reynolds. Species nova et pulchra. *Planta* succulenta, acaulescens vel caulibus usque ad 60 cm. longis. *Folia* 20—30, dense rosulata, arcuato-erecta, lanceolato-ensiformia, usque ad 65 cm. longa, 12 cm. lata ; supra planiuscula, laevia, subtus convexa ; marginibus dentibus brunneis 3 mm. longis, 7—15 mm. distantibus armata. *Inflorescentia* 1—1 ·3 met. alta ; scapus 2—6-ramosus. *Racemi* cylindrici, leviter acuminati, 35—45 cm. longi, 5—6 cm. diam. *Bracteae* lanceolato-acutae, scariosae reflexae, 14 mm. longae, 7 mm. latae. *Pedicelli* 3 mm. longi. *Perigonium* curvato-cylindricum, rubrum, usque ad 50 mm. longum. · *Segmenta exteriora* per 20 mm. libera, 5-nervata ; interiora nervis 5 coalitis carinata. *Genitalia* 10—12 mm. exserta. *Ovarium* 9 mm. longum, 4mm. diam.

Hab. Transvaal : On rocky slopes north of Tonteldoos, alt. 5,500 ft. approx., fl. 28 Feb., 1937, Reynolds 2308 ! (type) in National Herb.,

Pretoria, and Bolus Herb., Kirstenbosch ; on rocky slopes of Suikerboskop, fl. 4 March, 1937, Reynolds 2315 ! in Nat. Herb. and Bolus Herb. (Plate 20.)

This very distinctive new *Aloe* was first brought to my notice by Mr. F. W. Reitz (son of Dr. Hjalmar Reitz, M.P., and nephew of Col. Deneys Reitz, Minister of Agriculture), who discovered it on rocky slopes and among boulders north of the school at Tonteldoos, about 16 miles north-west of Dullstroom, Eastern Transvaal. Dr. F. Z. v.d. Merwe has found it growing on rocky slopes at Suikerboskop, which is 5 miles west of Schoongezicht School and 13 miles north-west of Belfast, and also records that the species is found in large numbers on the hills near Kliprivier School, 20 miles north of Tonteldoos.

In general habit of growth, rosettes, leaves, and inflorescences, *A. Reitzii* very closely resembles plants of *A. Gerstneri* Reynolds, but, as will readily be noticed from the accompanying illustrations, it differs considerably from its allies with its curved flowers 50 mm. in length. *A. Reitzii* is also allied to *A. petricola* Pole Evans, but the latter has more spreading, straighter leaves and smaller differently shaped flowers. Another ally, *A. aculeata* Pole Evans, differs with very aculeate leaves, and very different flowers. These two species flower during June-July, while *A. Reitzii* and *A. Gerstneri* flower in February-March.

Another affinity to be considered is *A. africana* Mill., in the section *Pachydendron*, to which species *A. Reitzii* seems allied with its curved 50 mm. long flowers ; *A. africana* is, however, a very different caulescent plant with different leaves and rosettes. (Note : Berger's figures in *Das Pflanzenreich*, p. 307, figs. D-E-F. of flowers of *A. africana* are not good representations. In plants in the wild state, plentiful in the Albany Division and elsewhere, the flowers are comparatively longer, narrower and more upturned than those figured by Berger.)

In very young plants of *A. Reitzii* the leaves are often copiously spiny on both surfaces, but with age these spines disappear, except sometimes for a few dorsally in median line near apex. In mature specimens rosettes reach 3 ft. in diameter ; the leaf sap dries brownish, while the flowers secrete a copious supply of clear nectar. A character worthy of mention is that the flowers are bright scarlet above, turning yellow to lemon on the underside ; this also occurs in *A. aristata* Haw.

Flowering in February-March before the frosts, *A. Reitzii* with its attractive racemes of bright crimson flowers, is a species well worth cultivating. The description is based on personal observations at the Tonteldoos and Suikerboskop localities during February-March, 1937.

Plants are at present in cultivation in the garden of the Botanical Section, Div. of Plant Industry, Pretoria, Nos. 1831.11.36 (ex Tontel-

doos) and 2457.3.37 (ex Suikerboskop); and in the National Botanic Gardens, Kirstenbosch, No. 2327/36 ex Tonteldoos.

Description.—Plant succulent, acaulescent or with stem up to 60 cm., the stem simple, rarely branched. *Leaves* lanceolate-ensiform, arcuate-erect densely rosulate, dull green, up to 65 cm. long, 12 cm. broad, the apices armed with a pungent thorn; upper surface flat or slightly concave, smooth, neither spotted nor lineate; lower surface convex, smooth, except sometimes for 4—8 thorns in median line near apex, the thorns pungent brownish, about 2 mm. long, 10—20 mm. distant; the margins armed with deltoid pungent brownish to reddish-brown teeth 3 mm. long, 7—15 mm. distant, more crowded low down, more distant upwards, the interspaces straight, the colour of the leaf or reddish-brown, never corneous. *Inflorescence* 1—1·3 met. high, 2—6-branched from below the middle. *Peduncle* 3·5—4·5 cm. diam. low down, ebracteate below the first branch, the branches below the racemes clothed with several sterile bracts. *Racemes* cylindric slightly acuminate, very densely multi-flowered, 35—45 cm. long, 5—6 cm. diam., usually terminating in a small tuft of wilted brownish bracts, the buds and flowers spreading downwards. *Bracts* lanceolate-acute, 14 mm. long, 7 mm. broad, thin scarious brownish, many nerved, very reflexed. *Pedicels* green, 3 mm. long. *Perianth* crimson above, the underside lemon, curved-cylindrical, up to 50 mm. long, the base rounded, not stipitate, about 7 mm. diam., enlarging to about 9 mm. above the middle thence slightly narrowing to the mouth, somewhat laterally compressed. *Outer segments* connate into a tube for 30 mm., the free portion 20 mm., the 2 upper segments scarlet with 5 reddish nerves turning slightly brownish at apex, the margins paler, the apices sub-acute and slightly falcately connivent, the lowest segment lemon, with 3—5 deeper lemon nerves, the apex sub-acute straight. *Inner segments* free but dorsally adnate to the outer to about the middle, with thin white margins; the uppermost segment with a 20 mm. keel the colour of the perianth turning brownish at apex; the 2 lowest segments with a less pronounced keel formed by 3 crowded, greenish nerves. *Filaments* distinctly flattened, pale lemon within the perianth, the 10 mm. exserted portion brownish-orange. *Anthers* exserted 10 mm. *Style* yellower than the filaments, the exserted portion not changing colour. *Stigma* at length exserted 10—12 mm. *Ovary* olive green, 9 mm. long, 4 mm. diam. at base. *Capsule* 25 mm. long, 14 mm. diam.

Aloe Lettyae, Reynolds. Species nova in sectione *Saponariarum. Planta* succulenta, acaulescens. *Folia* circiter 20, dense rosulata, erecto-patentia, lanceolato-attenuata, usque ad 45 cm. longa, 9 cm. lata, supra

et subtus viridia et maculata, ad margines sinuato-dentata, dentibus deltoideis brunneis 3—4 mm. longis, 10—15 mm. distantibus armata. *Inflorescentia* 1·75 met. alta ; scapus 8—12-ramosus. *Racemi* cylindrici leviter acuminati, usque ad 20—25 cm. longi, 8—9 cm. diam. *Bracteae* deltoideo-acuminatae, pedicellis aequantes. *Perigonium* rubrum, 38—42 mm. longum, basi globoso-inflatum et 10—11 mm. diam., supra ovarium constrictum et 6 mm. diam., hinc leviter decurvatum et fauces versus leviter ampliatum. *Segmenta* exteriora per 10 mm. libera, interiora latiora et obtusiora. *Genitalia* 1—2 mm. exserta. *Ovarium* 8 mm. longum, 3·5 mm. diam.

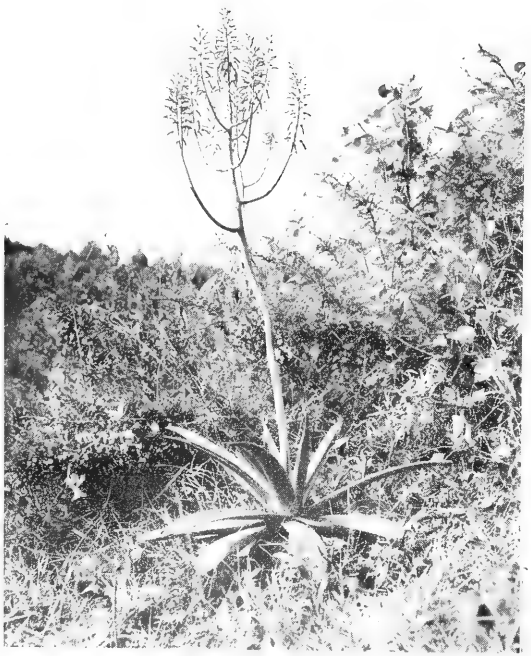
Hab. Northern Transvaal : Cultivated plant ex. Westfalia, fl. March, 1935, in Pretoria, Letty 299 ! ; Duivelskloof, April, 1936, van Balen ! Nat. Herb. 21357 ; near Duivelskloof in long grass and among bushes, alt. 3,100 ft., fl. 26 March, 1937, Reynolds 2339 ! (type) in National Herb., Pretoria, and in Bolus Herb., Kirstenbosch. (Plate 21.)

This new *Aloe* is named after Miss C. Letty, (Artist at the Division of Plant Industry, Pretoria) who collected it about 3 years ago near Duivelskloof, northern Transvaal, and whose coloured Plates in *Flowering Plants of South Africa* are so well known. Up to the present Miss Letty has figured about 400 species of various genera, of which about 50 are of *Aloe*.

A. Lettyae occurs in long grass and among bushes and trees on eastern slopes of the northern extremity of the Drakensberg near Duivelskloof, and southwards to near the top of Magoebas Kloof, and is described from personal observations at those localities during 1936-37.

The species appears to occur as solitary plants, small groups were not noticed. It is distinguished from other known species in the section *Saponariae* by the shape of the flowers, and the leaf markings. As will be noticed from the accompanying figure, the base of the perianth is remarkably globular, and although flowers vary in length and width, judging from much material examined, the globular basal swelling appears to be a fixed character. In all plants examined the leaf lower surface was obscurely spotted, which also appears to be a fixed character. The marginal teeth are mostly 3—4 mm. in length, and not joined by a heavy corneous edge. In the largest specimens the inflorescence reaches 5—6 feet in height, bearing a total of about 20 racemes. In plants growing in shady, protected positions, the bracts are more fleshy and longer than their pedicels, while in more exposed positions they are more scarious and shorter.

A. Lettyae appears to be nearest allied to *A. deWetii* Reynolds hereinafter described, but differs principally with leaves spotted on both sides, the laxer less acuminate racemes, and the globular basal swelling of the



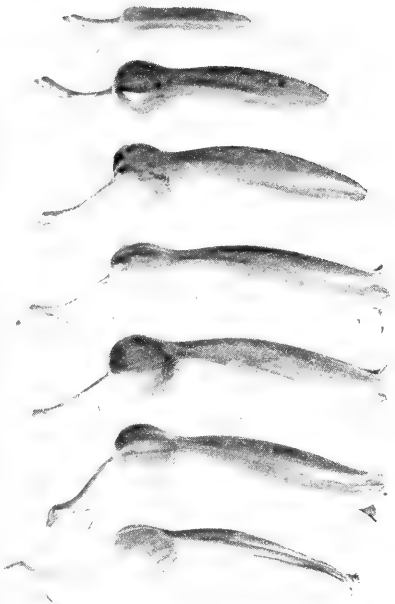


FIG. 1. FIG. 2.

PLATE 21. *Aloe Lettyae* Reynolds.

FIG. 1. Plant in natural habitat, fl. 26 March, 1937, near Duivelskloof, Northern Transvaal, height 5 ft.
FIG. 2. Flowers 1/1, from bud to post-pollination stage. (Note the very globular basal swelling.)

Fig. 1.

Fig. 2.

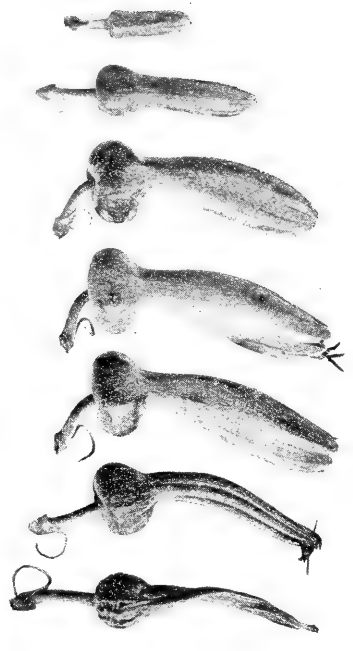


Fig. 3.

Plate 22. *Aloe de Wetii* Reynolds.

Figs. 1-2. Plants in natural habitat, 4 miles east of Alpha in the Mkuzi River valley, Zululand (26 miles east of Vryheid on the road to Nongoma), fl. 6 March, 1937, height 6 ft.

Fig. 3. Flowers 1/1, from bud to post-pollination stage.

perianth. *A. transvaalensis* O. Kuntze is a smaller plant with very different leaves and flowers, while *A. komatiensis* Reynolds, which also flowers in February-March in the bushveld between Kaapmuiden and Komatipoort, is distinguished by longer, much narrower leaves, and differently shaped smaller flowers. *A. Simii* Pole Evans is another February-flowering ally, but has thinner unspotted greyer leaves, much laxer racemes, and differently shaped flowers.

Plants are at present in cultivation in the garden of the Botanical Section, Division of Plant Industry, Pretoria, Nos. 1306/7.5.36, and in the National Botanic Gardens, Kirstenbosch No. 1257/36.

Description.—Plant succulent, solitary, not stoloniferous, acaulescent. *Leaves* about 20 in a dense rosette, erectly spreading, lanceolate-attenuate, up to 45 cm. long, 9 cm. broad at base ; upper surface slightly concave, dull green with numerous dull white spots throughout, the spots elongate and scarcely arranged in undulating transverse bands ; lower surface convex, dull green, obscurely spotted throughout, the spots larger, more obscure and more in undulating transverse bands ; margins sinuate-dentate, armed with deltoid brownish firm teeth about 3—4 mm. long, 10—15 mm. distant, the interspaces usually the colour of the leaf, sometimes slightly corneous and pale brownish. *Inflorescence* a branched panicle up to 1·75 met. high. *Peduncle* flattened low down, about 3 cm. diam., 8—12-branched from about the middle, the lowest branches with 1—3 branchlets producing a total of 15—20 racemes. *Racemes* cylindric slightly acuminate, the terminal the highest, 20—25 cm. long, 8—9 cm. diam. *Bracts* deltoid-acuminate, about as long as their pedicels, thin subscarious pale brown, 3—5-nerved. *Pedicels* 12—15 mm. long. *Perianth* nearest Rose Red (R.C.S. XII), 38—42 mm. long, with a globular basal swelling 10—11 mm. diam., constricted to 6 mm. above the ovary, thence slightly decurved and enlarging towards the throat, the mouth slightly pale brownish. *Outer segments* free for 10 mm., obscurely nerved, with paler margins and sub-acute slightly spreading apices. *Inner segments* dorsally adnate to the outer for 30 mm., broader than the outer, with broader white marginal border and more obtuse apices. *Filaments* almost white, the 3 inner narrower and lengthening in advance of the 3 outer. *Genitals* exserted 1—2 mm. *Ovary* 8 mm. long, 3·5 mm. diam., finely 6-grooved, green. *Capsule* 30 mm. long, 15 mm. diam. at middle.

Aloe deWetii, Reynolds. Species nova in sectione *Saponariarum*. *Planta* succulenta, acaulescens, nec stolonifera. *Folia* circiter 20, dense rosulata, erecto-patentia, lanceolato-attenuata, usque ad 48 cm. longa, basi 13 cm. lata ; supra leviter canaliculata, viridia, albo-maculata ;

subtus convexa, immaculata, obscure lineata ; ad margines sinuato-dentata, marginibus brunneis corneis, dentibus deltoideis brunneis, usque ad 10 mm. longis 10—15 mm. distantibus armata. *Inflorescentia* usque ad 2 met. alta. *Scapus* medio circiter 10-ramosus. *Racemi* cylindrico-acuminati, terminales usque ad 40 cm. longi, 7 cm. diam. *Bracteae* anguste deltoideae, 20 mm. longae, 3 mm. latae. *Pedicelli* usque ad 15 mm. longi. *Perigonium* sordide rubrum, 35—40 mm. longum, basi globoso-inflatum et usque ad 14 mm. diam., supra ovarium constrictum, 6—7 mm. diam., leviter decurvatum et fauces versus ampliatum. *Segmenta exteriora* per 6 mm. libera, obscure 5-nervata, marginibus pallidioribus ; interiora latiora, obtusiora. *Genitalia* vix exserta. *Ovarium* viride, 10 mm. longum, 4 mm. diam.

Hab. Zululand : In the Umkuzi valley 4 miles east of Alpha, 26 miles east of Vryheid on the Nongoma road, fl. 6 March, 1937, Reynolds 2319! (type) in National Herbarium, Pretoria, and in Bolus Herb., Kirstenbosch. (Plate 22.)

This new species is found in fairly large numbers in flat grassy places, or gentle slopes, in the Umkuzi valley 4 miles east of Alpha, which is 26 miles east of Vryheid, on the road to Nongoma. It is named after Mr. J. F. de Wet, Headmaster, Vryheid Junior School. Mr. de Wet also records the species from near Ingwavuma in the Lebombo range, and has found specimens reaching a height of 8 feet, 6 miles north of Hlabisa, while the writer has collected plants which appear to be conspecific, at a point 7 miles south of Nongoma, Zululand. The species is described from personal observations at the Alpha locality during March, 1937. *A. deWetii* is nearest allied to *A. Lettyae*, and while due allowances must be made for species in the section *Saponariae* varying considerably in their different geographical stations, it appears to be specifically distinct. A most striking feature of *A. deWetii* is the leaves, which have a peculiar dull glossy appearance, as if rubbed with an oily cloth ; the teeth are very stout, reaching a length of 10 mm., and are joined by a very pronounced horny brownish marginal edge. In *A. Lettyae* the leaves are duller, the marginal teeth much smaller, the interspaces hardly horny. Another difference is that in all plants of *A. deWetii* examined, the leaf lower surface was immaculate, while in *A. Lettyae* the lower surface was always obscurely spotted. *A deWetii* also differs from *A. Lettyae* in the more nerved bracts, the comparatively broader redder flowers, which have a broader but less globular basal swelling, and are more thickly coated with bloom. Reference to the accompanying figures will show the difference in the inflorescence ; in *A. deWetii* the racemes are slightly denser, longer and more acuminate than those of *A. Lettyae*.

Plants are at present in cultivation in the garden of the Botanical

Section, Div. of Plant Industry, Pretoria, No. 1515.7.36, and in the National Botanical Gardens, Kirstenbosch, No. 1713/36.

Description.—Plant succulent, acaulescent, solitary, not stoloniferous. *Leaves* about 20 in a dense rosette, erectly-spreading, lanceolate-attenuate, up to 48 cm. long, 13 cm. broad at base ; upper surface slightly canaliculate, dull green, with numerous dull white spots throughout, the spots elongate, irregularly scattered, sometimes arranged more or less into a series of irregular undulating transverse bands ; lower surface convex, immaculate, obscurely lineate ; margins sinuate-dentate with a pronounced heavy corneous brown edge, armed with deltoid pungent stout brown teeth up to 10 mm. long, 10—15 mm. distant. (Note : The leaves have a peculiar dull glossy appearance, as if rubbed with an oily cloth.) *Inflorescence* a branched panicle up to 2 met. high in large specimens. *Peduncle* about 5 cm. diam. low down, brownish, covered with a greyish powdery substance, about 10-branched from about the middle, the lowest branches with 1—4 branchlets producing a total of 15—25 racemes, the lowest branch subtended at base by a rather fleshy bract up to 9 cm. long, 3 cm. diam., with a few teeth near apex. *Racemes* the terminal the highest, cylindric-acuminate, up to 40 cm. long, 7 cm. diam., lateral racemes shorter. *Bracts* narrowly deltoid, 20 mm. long, 3 mm. broad at base, thin scarious brownish 7—9-nerved. *Pedicels* the lowest of terminal racemes up to 15 mm. long. *Perianth* dull scarlet with a bloom, 35—40 mm. long, with a basal swelling up to 14 mm. diam., constricted to 6—7 mm. above the ovary, thence slightly decurved and enlarging towards the throat, the mouth distinctly trigonous. *Outer segments* free for 6 mm., obscurely 5-nerved, with paler margins, the apices sub-acute brownish. *Inner segments* broader than the outer, the apices more obtuse. *Filaments* white, much flattened, the 3 inner narrower and lengthening in advance of the 3 outer. *Anthers* scarcely exserted. *Stigma* at length exserted 1—2 mm. *Ovary* green, 10 mm. long, 4 mm. diam., finely 6-grooved. *Capsule* 30 mm. long, 16 mm. diam., for some time enwrapped with the remains of the dry perianth.

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A NEW ALOE FROM SOUTH-WEST AFRICA, TOGETHER WITH NEW VARIETIES FROM THE TRANSVAAL AND ORANGE FREE STATE.

(With Plates 23—25)

By G. W. Reynolds.

There are a few known new species of *Aloe* in the Mandated Territory of South-West Africa awaiting description, but it seems that since 1924, when *A. pachygaster* Dinter was published, little or nothing has been done towards clearing them up. With a view to assisting in this direction, the writer has succeeded in getting together in Johannesburg a representative collection of *Aloe* species (and possible crosses), from most parts of S.-W. Africa. When these plants flower, and after allowing for hybrids, the writer hopes to be able to describe and illustrate some of them without much further delay.

In the present paper, a very distinctive new *Aloe* with green flowers, from near Windhoek, is described, together with a new variety from the Transvaal and a new variety from the Orange Free State.

Aloe viridiflora, Reynolds. Species nova, floribus viridulis facile distinguitur. *Planta* succulenta, acaulis. *Folia* 50—60, dense rosulata, basi 8 cm. lata, sensim attenuata et 40 cm. longa, supra planiuscula, subtus convexa, utrinque glauca lineata immaculata, ad margines dentibus deltoideis rectis 2 mm. longis, 2—5 mm. distantibus armata. *Inflorescentia* 1·5 met. alta ; scapus medio circiter 6-ramosus. *Racemi* capitati, 10 cm. longi, 8 cm. lati. *Pedicelli* 20 mm. longi. *Bracteae* ovato-acutae, 7 mm. latae, 15 mm. longae, scariosae, 7—9-nervatae. *Perigonium* viridulum, clavato-cylindraceum, 33 mm. longum, fauces versus circiter 9—10 mm.

diam. *Segmenta exteriora* fere libera, circiter 9-nervata ; *interiora* libera, nervis tribus viridulis approximatis carinata. *Genitalia* 10 mm. exserta. *Ovarium* 5 mm. longum, $2\frac{1}{4}$ mm. diam.

Hab. Mandated Territory of South-West Africa : On the farm " Rietfontein," Hohenschein mountain, 60 miles east of Windhoek, cultivated plant fl. 25 September, 1936 in Johannesburg, Reynolds 1626 ! (type) in National Herbarium, Pretoria. (Plate 23).

This very distinctive new *Aloe* was discovered in 1932 by Mr. W. Triebner, on rocky slopes near the top of Hohenschein mountain at about 6,000 ft., on the farm " Rietfontein," about 60 miles east of Windhoek. Mr. Triebner records that plants are found in fair numbers, solitary and not suckering, and that he has also found them 70 miles north of Rehoboth.

The most striking feature of *A. viridiflora*, as the name implies, is the peculiar greenish colour of the flowers, a flower colour which does not appear to have been recorded in any *Aloe* hitherto described.

As will be noticed from the accompanying figure, the perianth gradually tapers into the pedicel, the flowers in shape thus very closely resembling those of *A. claviflora* Burch.,[1] in the Section *Asperifoliae*. In *A. claviflora* the pedicels are shorter, the outer segments free for only 15 mm., while *A. viridiflora* has longer pedicels, with the outer segments free almost to base.

In general habit of growth, shape and size of rosette and leaves, and in branching and racemes (but not shape and colour of flowers), *A. viridiflora* seems nearest allied to *A. hereroensis* Engl. which Berger places in the Section *Saponariae*. The writer does not agree with Berger in this respect, and feels that *A. hereroensis* should constitute a new section. *A. viridiflora* certainly cannot be referred to the *Saponariae ;* in some respects it is near the Section *Asperifoliae*, but it does not fit well into any existing section.

As regards cultivation, many of the *Aloes* from Great and Little Namaqualand are difficult to establish away from their natural habitat, especially in localities of much higher rainfall ; good drainage is essential. Planting the stems *in* the ground is almost invariably fatal. The large plant of *A. viridiflora*, when received, was merely firmed down *on* to a raised bed of pebbles 6 inches deep, and never watered. It rooted quickly and flowered in Johannesburg during September, 1936, when the description was drawn up. The plant illustrated is about 5 years old ; Mr. Triebner records that in their natural habitat, the largest specimens have rosettes 3 feet diam., and produce 4 and more inflorescences.

[1] In the January 1938 Part of this JOURNAL full reasons will be given for upholding *A. claviflora* Burchell and reducing *A. Schlechteri* Schonl. to synonymy.

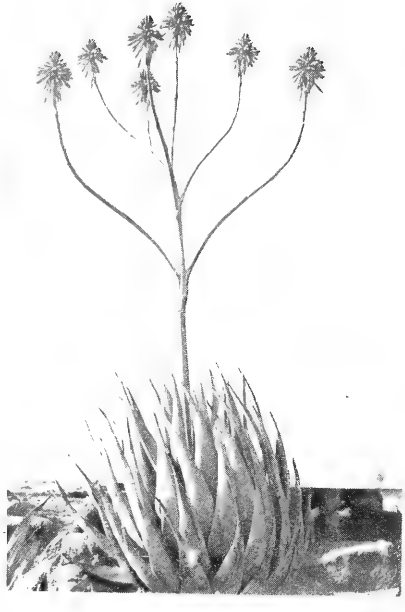


FIG. 1.

FIG. 2.

FIG. 3.

PLATE 23. *Aloe viridiflora* Reynolds.

FIG. 1. The type plant, height 5 feet, fl. 25 September, 1936, in the author's garden in Johannesburg; originally collected by Mr. W. Triebner near the top of Hohenscheim Mountain, about 60 miles east of Windhoek, S.W. Africa. (*Note.*—In the wild state rosettes are 2-3 feet diam., with 4 and more inflorescences.)

FIG. 2. Raceme × $\frac{1}{3}$ approx.

FIG. 3. Flowers natural size from bud to post-pollination stage.

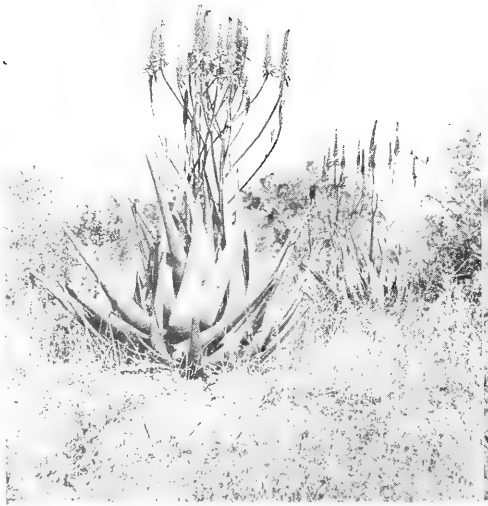


Fig. 1.

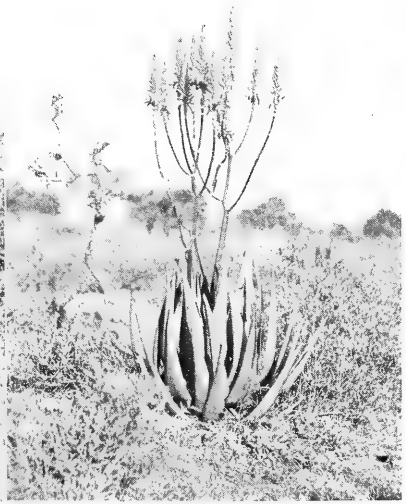


Fig. 2.

Fig. 3.

Plate 24. *Aloe Wickensii*. Pole Evans, var. *lutea* Reynolds.

Fig. 1. Plant in natural habitat, 8 miles north of Burgersfort, Lydenburg Dist.. Eastern Transvaal, fl. 20 June, 1937.
Fig. 2. Another specimen, 2 miles east of Burgersfort, fl. 20 June, 1937.
Fig. 3. Flowers natural size.

In order to prevent confusion, it might be advisable to mention that *A. viridiflora* is the species hitherto known to a few under the unpublished manuscript name of *A. Riehmeri*.

Description.—Plant succulent, acaulescent, solitary. *Leaves* 50—60 in a compact dense rosette, arcuate-erect with the apices slightly recurved, 8 cm. broad at base, gradually attenuate and up to 40 cm. long ; upper surface flat low down, slightly canaliculate upwards, glaucous, immaculate, obscurely lineate ; lower surface convex, immaculate, lineate, glaucous with a pinkish tinge ; margins sinuate-dentate, armed with deltoid pungent straight pinkish-brown teeth 2 mm. long, 2—5 mm. distant. *Inflorescence* a branched panicle 1·5 met. high. *Peduncle* flattened and 3 cm. diam. low down, 6-branched from about the middle, the branches erectly spreading in lower half, thence arcuate-erect, the lowest branches subtended at base by thin, scarious, pale brownish ovate-acute many-nerved bracts 25 mm. long, 30 mm. broad ; without sterile bracts below the first branch, the branches below the racemes clothed with several ovate-acute thin, scarious, many-nerved sterile bracts about 16 mm. long, 8 mm. broad. *Racemes* capitate, densely 50—60 flowered, 10 cm. long, 8 cm. diam. at middle, conical in upper half with buds erect, thence gradually horizontally disposed to cernuous, with the open flowers distinctly pendulous and lying close to the main axis. *Pedicels* green, 20 mm. long, reaching 30 mm. in the fruit. *Bracts* ovate-acute, 15 mm. long, 7 mm. broad at base, thin, scarious, pale brownish, marked with about 7—9 pale brownish nerves. *Perianth* green, tinged with lemon about the middle, clavate-cylindric, 33 mm. long, 9—10 mm. diam. at widest part near throat, gradually tapering into the pedicel. *Outer segments* free almost to base, with about 9 crowded green nerves, the margins paler, the apices sub-acute, scarcely spreading. *Inner segments* free, not cohering dorsally to the outer, greenish-orange in colour, with 3 congested greenish nerves forming a keel, the apices brownish and more obtuse than the outer, with the margins edged with brown for 5 mm. from apex. *Filaments* slightly flattened, the 3 inner slightly narrower and lengthening in advance of the three outer, the included part lemon, the exserted portion (10 mm.) deep orange. *Anthers* in turn exserted 10 mm. *Stigma* exserted 10—12 mm. *Ovary* green, 5 mm. long, $2\frac{1}{4}$ mm. diam., finely 6-grooved.

Aloe Wickensii, Pole Evans, var. **lutea** Reynolds. Varietas nova, a forma typico alabastris luteis et racemis luteis unicoloris differt.

Hab. Transvaal : Lydenburg District, near Burgersfort, fl. 22nd June, 1936, Reynolds 1476 ! ; Waterval Valley, 21 miles N.-W. of Lydenburg, fl. 11 July, 1936, Reynolds 1945 ! ; Buffelsvlei, fl. 11 July, 1936, Rey-

nolds 1946 !; Burgersfort fl. 11 July, 1936, Reynolds 1949 ! (type). Pietersburg Dist. : 10 miles N.-W. of Malips Drift, fl. 22 June, 1936, Reynolds 1356 !, all in National Herbarium, Pretoria, and Bolus Herb., Kirstenbosch. Plants 1653/35 (ex Burgersfort) in National Botanic Gardens, Kirstenbosch; No. 1415.7.36 (ex Waterval Valley) and 1416.7.36 (ex Burgersfort) in garden of Botanical Section, Div. of Plant Industry, Pretoria. (Plate No. 24.)

Before discussing varietal characters, it is advisable to attempt to clear up the confusion existing concerning the identity and distribution of *A. Pienaarii* Pole Evans and *A. Wickensii* Pole Evans. These two species though closely allied, are distinct, but there are large numbers of plants in public and private gardens which do not fit the description of either species. Evidently those plants must have originated from localities where both *A. Pienaarii* and *A. Wickensii* grow socially, cross freely, and produce a tremendous variation in shape, size and colour of racemes and flowers.

Briefly, in typical *A. Pienaarii* the inflorescence is compactly 5—8-branched, the buds and flowers are dull scarlet, the cylindric-acuminate racemes presenting a more or less unicoloured reddish effect, with the flowers 40—45 mm. long, cylindric-trigonous and rather straight.

In typical *A. Wickensii* the inflorescence is more divaricately branched and usually bears only three racemes ; the racemes are shorter and more conical, the buds are dull reddish with the open flowers lemon-yellow, the racemes thus presenting a distinctly bicoloured effect. The flowers are distinct from those of *A. Pienaarii*, being shorter, broader, with the mouth upturned and the lowest outer segment distinctly naviculate.

A. Pienaarii occurs at Smit's Drift, 23 miles east of Pietersburg, (type locality) and extends westward and southwards through the Rustenburg and Groot Marico districts to Lobatsi in Bechuanaland. In this area it is not found in association with *A. Wickensii* and these plants, though variable, are typical of the species.

A. Wickensii occurs south of the Chunes Mountains, westwards to Chunes Poort 23 miles south of Pietersburg, (type locality) and extends westwards to Zebediela and Potgietersrust. In this area it is not found growing socially with *A. Pienaarii*, these plants being typical of the species. From Smits Drift *A. Pienaarii* extends southwards, while from Chunes Poort *A. Wickensii* extends eastwards until they meet at a point about 10 miles North-West of Malips Drift. At this locality, doubtless due to hybridisation, an amazing variety of shapes, sizes and colours of racemes and flowers occurs, while throughout M'Phathlele's Location and Secocoeniland, and especially in the Olifants, Steelpoort, Waterval and Spekboom River valleys, this confusion is maintained. It is therefore

evident, that unless carefully selected when flowering, plants from these localities might turn out to be crosses of various generations and segregations, which will not fit the description of either *A. Wickensii* or *A. Pienaarii*.

Near Burgersfort and in that neighbourhood, plants occur with yellow buds and yellow flowers, the racemes thus being unicoloured yellow. It has been suggested that such plants are also crosses between *A. Pienaarii* and *A. Wickensii*, but this can hardly be the case since yellow buds is a character neither of the unicoloured reddish racemed *A. Pienaarii* nor of the bicoloured *A. Wickensii*. These plants therefore well merit varietal rank. The variety is variable in branching, the inflorescence being compactly or divaricately 3—6-branched, while it is also variable in length and shape of flowers. The usual length of the perianth is 35 mm., in weak forms it is sometimes only 31 mm., while in strong forms a length of 40 mm. is reached, in which case the perianth is usually straighter. In shape size and colour of flowers, it is mostly nearer *A. Wickensii* and for this reason a var. *lutea* to *A. Wickensii* is proposed.

The var. *lutea* seems to have its headquarters in the vicinity of Burgersfort, it extends southwards to the Waterval Valley (21 miles from Lydenburg), westwards along the Steelpoort River to Steelpoort and beyond, and northwards to a point 10 miles beyond Malips Drift. It is a particularly handsome plant, and one well worth cultivating ; it flowers usually in June—July, and should be given some protection from frosts. The chief distinguishing characters of the variety are the flowers nearer *A. Wickensii* in shape, size and colour, and the yellow buds and yellow flowers forming unicoloured yellow racemes.

Description : *Plant* succulent, acaulescent or very shortly caulescent, solitary, with stem simple, sometimes in small groups of 2—4 plants. *Leaves* about 30, densely rosulate, ensiform or gradually attenuate from the base, arcuate-erect, sometimes incurved, up to 90 cm. long, 11—12 cm. broad at base in old specimens ; upper surface flat to slightly canaliculate, lower surface convex, both surfaces coriaceous, dull grey-green, immaculate ; margins sinuate-dentate, armed with deep brown deltoid pungent teeth 2 mm. long, 2—10 mm. distant, usually more crowded near base, more distant near apex, sometimes bifid, usually isolated and directed forward. *Inflorescence* up to 1 ·5 met. high, 2—3 simultaneously, compactly to divaricately 3—5-branched from about the middle. *Peduncle* brown, biconvex and 3—5 cm. diam. at base ; the branches usually arcuate-erect and subtended at base by thin scarious many-nerved pale brown ovate acuminate bracts. *Racemes* unicoloured yellow, densely cylindric-acuminate, 20—25 cm. long, the yellow buds greenish to pale orange tipped, sub-erect, usually obscured by their longer spreading

bracts, the open flowers slightly laxer, cernuous to subpendulous. *Bracts* ovate in lower half, acuminate above, up to 25 mm. long, 18 mm. broad at base, very thin, subscarious, pale brown, about 12-nerved. *Pedicels* lowest up to 25 mm. long, up to 30 mm. in the fruit. *Perianth* lemon-yellow, (R.C.S.) cylindric-trigonous with upturned mouth, 32—40 mm. in length, 35 mm. the usual. *Outer segments* free, faintly pale nerved throughout their length, the two upper more closely grouped, the lowest naviculate, the apices sub-acute, spreading, somewhat brownish-tipped. *Inner segments* free, not cohering to the outer, broader than the outer, with thin white margins and with 3—5 congested nerves in median line, the apices brownish, more obtuse and more spreading to revolute than the outer. *Filaments* lemon-yellow, much flattened, the 3 inner narrower and lengthening in advance of the 3 outer. *Anthers* the inner and outer in turn exserted 2—4 mm. *Stigma* at length exserted 5—8 mm. and remaining exserted after pollination. *Ovary* 9 mm. long, 4·5 mm. diam. at middle, 6-grooved, green. *Capsule* 26 mm. long, 13 mm. diam. 6-grooved, green, for a long time enwrapped with the remains of the dry perianth.

Note.—The leaf sap is purplish-lilac (R.C.S.) in colour.

Aloe saponaria (Ait.) Haw., var. **ficksburgensis** Reynolds. Varietas nova, a forma typico pedicellis floribusque brevioribus, racemis parvis late conicis differt.

Hab. Orange Free State : On northern slopes of sandstone hills at Molen Spruit, 4 miles west of Ficksburg, fl. 6 Sept., 1936, Reynolds 2087 ! (type) ; 2086 ! (forms). Basutoland : 4 miles south of Leribe, fl. 8 Sept., 1936, Reynolds 2089 ! (typical) and 2090 ! (red flowered form), all in National Herb., Pretoria. Plants No. 1674.8.36 in Garden of Bot. Sect., Div. of Plant Industry, Pretoria ; and No. 1824/36 in National Bot. Gardens, Kirstenbosch. (Plate No. 25.)

Plants regarded as belonging to the species *A. saponaria* (Ait.) Haw., found from the Cape Peninsula through the Eastern Province and Transkei into Natal, though variable, are characterised principally by their corymbose racemes 10—15 cm. diam., with the pedicels and flowers 35—50 mm. long. The var. *ficksburgensis* differs with racemes smaller more broadly conical or round topped, with shorter pedicels (25 mm. against 35—50 mm.), and shorter flowers (35 mm. against 40—50 mm.). In *A. saponaria* the bracts are mostly one quarter to one half the length of their pedicels, while in the variety they are as long as their pedicels or a little longer ; in *A. saponaria* the pedicels are usually as long as the perianth and longer, and sometimes reach 60—70 mm. in strong forms, while in the variety the flowers are longer than their pedicels.

FIG. 1.

FIG. 2.

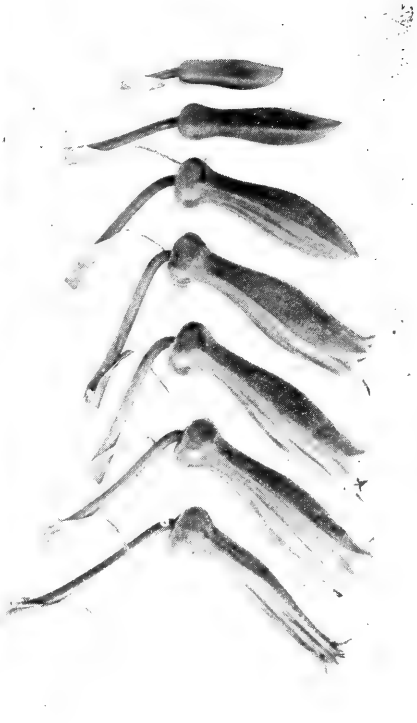


FIG. 3.

PLATE 25. *Aloe saponaria* (Ait.) Haw., var. *ficksburgensis* Reynolds.

FIG. 1. Plants fl. 6 September, 1936, at Molen Spruit, 4 miles west of Ficksburg, O.F.S.
FIG. 2. A raceme × $\frac{1}{3}$ approx.
FIG. 3. Flowers 1/1, from the bud to post-pollination stage.

The var. *ficksburgensis* is named after the locality where it is found in considerable quantities, namely, on northern slopes of a sandstone hill at Molen Spruit, 4 miles west of Ficksburg ; it is also found on a hill about two miles north of Ficksburg, and near Leribe and Pitsing in Basutoland.

Plants are variable, in some the racemes are more corymbose or more conical than the raceme figured, while flowers vary in length from 30 mm. in weak forms to 40 mm. in the strongest. Some plants appear to differ sufficiently to be specifically distinct, but it is considered more advisable to accord them only varietal rank. From an examination of a large amount of material, and the measurements tabulated, it was found that racemes averaged 8 cm. diam. with the apex rounded or broadly conical, pedicels and bracts 25 mm. long, the flowers 35 mm. in length, which are the principal distinguishing features of the variety.

The variety suckers freely, forming dense groups ; usually there is only one inflorescence from a rosette, simple or with one to two branches. The predominating colour of flowers is Salmon-orange or Capucine-yellow (R.C.S.) although occasionally plants are found with yellow, orange, or reddish flowers. The description is based on personal observations at the localities cited during September 1935 and 1936.

Description.—Plants acaulescent or very shortly caulescent, freely suckering and forming dense groups. *Leaves* about 16, densely rosulate, obliquely spreading, broadly and shortly lanceolate, about 10 cm. long with an additional 5—10 cm. of dried twisted apex, about 8 cm. broad at base ; upper surface greenish near base, rather brownish upwards, slightly canaliculate, with numerous spots confluent and more or less arranged in undulating interrupted transverse bands ; lower surface convex, paler green, usually immaculate, sometimes with obscure immersed spots ; margins sinuate-dentate with horny edge, armed with light brown deltoid pungent straight teeth 4—5 mm. long, 10 mm. distant, the interspaces rounded. *Inflorescence* usually about 50 cm. high, sometimes 2 from a rosette, simple or with 1—2 branches from the middle or lower ; peduncle brown, flattened low down and 20—30 mm. diam., clothed in upper half with a few ovate-acuminate many-nerved sterile bracts up to 30 mm. long. *Racemes* capitate, 7—8 cm. long, 8 cm. broad, with densely congested sub-erect buds forming a rounded or broadly conical apex, the open flowers sub-pendulous. *Pedicels* 25 mm. long, reaching 30 mm. in the fruit. *Bracts* deltoid-acuminate, thin scarious 7—9-nerved, as long as their pedicels. *Perianth* nearest Capucine-yellow (R.C.S. Plate III), 35 mm. long, with an 8 mm. diam. basal swelling, constricted to 5 mm. above the ovary, thence slightly decurved and enlarging towards the throat and forming an open triangular mouth.

Outer segments free for 10 mm., paler at the margins, the apices subacute, straight or slightly spreading. *Inner segments* dorsally adnate to the outer for 25 mm., broader than the outer and with more obtuse more spreading apices. *Filaments* pale lemon, flattened, the 3 inner narrower and lengthening in advance of the 3 outer. *Anthers* exserted 1—2 mm. *Stigma* at length exserted 2—3 mm. *Ovary* 7 mm. long, 3 mm. diam. at base, finely 6-grooved, green. *Capsule* oblong, 26 mm. long, 15 mm. diam. at middle.

VERY DISTINCTIVE NEW ALOE FROM MOCAMBIQUE.

(With Plate 26.)

By G. W. Reynolds.

In the present paper a very distinctive and unique new *Aloe* from Mocambique is described.

Aloe suffulta, Reynolds. Species nova et distinctissima in sectione *Saponariarum*. *Planta* succulenta, nec sobolifera nec caespitosa, breviter caulescens. *Folia* circiter 16, laxe rosulata, basi 4 cm. lata, longe attenuata et saepe 40—50 cm. longa, patentia et recurvula; supra canaliculata viridia, copiose albo-maculata; subtus convexa, maculata; ad margines dentibus uncinatis albis 1—2 mm. longis, 5—10 mm. distantibus instructa. *Inflorescentia* una, suffulta, usque ad 2 met. alta; scapus insigniter gracilis, supra medium 6—9 ramosus. *Racemi* cylindrico-acuminati, terminales circiter 15 cm. longi, laxe 15—20 floribus. *Bracteae* sub-scariosae albidae 7-nervatae, pedicellis aequantes. *Pedicelli* 9 mm. longi. *Perigonium* 30—35 mm. longum, cylindrico-trigonum, basi 6 mm. diam. haud inflatum, supra ovarium levissime constrictum (5·5 mm. diam.) faucem versus levissime ampliatum. *Segmenta* exteriora per 7 mm. libera, obscure 5-nervata, apice recurvula; interiora latiora obtusiora. *Genitalia* 6 mm. exserta. *Ovarium* 6 mm. longum, 2·5 mm. diam.

Hab. Mocambique: Under bushes near Vila Luiza (Marracuene), about 19 miles north of Lourenco Marques, alt. 300 ft., fl. 13 June, 1937, Reynolds 2457! (type) in National Herbarium, Pretoria; and in Bolus Herb., Kirstenbosch. Plants No. 2811.6.37 in Garden of Botanical Section, Div. of Plant Industry, Pretoria, and No. 862/37 in National Botanic Gardens, Kirstenbosch. (Plate 26.)

This very distinctive new *Aloe* was brought to my notice by Mr. C. Foster, of Krugersdorp, who collected specimens at Marracuene about two years ago. A plant kindly donated by Mr. Foster has been in cultivation in Johannesburg, but has not yet flowered. On 13 June, 1937, I made a special journey to Mocambique for the express purpose of investigating this species, and was most fortunate to find many plants in full bloom. The species is found in fairly large numbers on the west

bank of the Incomati River about one mile south of Vila Luiza (also known as Marracuene), which is about 19 miles north of Lourenco Marques at an elevation of 300 ft. Plants are found under bushes in shady protected positions, growing in almost pure white sand covered with leaf mould and humus, and are so loosely in the ground that they can be removed by hand with scarcely any resistance.

Although very distinctive in rosette and leaf, the most striking feature of the species is that the inflorescence works its way up through bushes and is supported by them. This character appears to be unique in *Aloe* and suggests the specific epithet. The rosettes are on the ground, only the inflorescence being supported by bushes, which is very different from the scandent growth of *A. ciliaris* Haw., in which stems, rosettes and inflorescences are all supported by bushes and trees. In *A. suffulta* the usual height of the inflorescence is about 5 feet (Fig. 1), although one specimen was noticed with an inflorescence 7 feet high. (Fig. 2.) In all cases the peduncles were exceedingly slender, being only 7—9 mm. diam., and totally unable to support the weight of their inflorescences. It will be interesting to observe whether plants cultivated away from bushes will develop stouter peduncles capable of supporting their inflorescences.

The leaves are sheathed at base somewhat similar to *A. striatula* Haw., and are green, spotted throughout on both surfaces, deeply channelled and gracefully recurved, usually 40—50 cm. long, although a length of 75 cm. is sometimes reached in the most robust forms. In protected positions the marginal teeth interspaces are the green colour of the leaf, but in more exposed positions the leaves are more reddish-brown, with the interspaces joined by a very narrow sub-cartilaginous whitish line.

A noteworthy character of the branching of the inflorescence is that the raceme is usually about as long as the branch below it, *i.e.* total length of branch and raceme about 16 cm., of which the raceme is 8 cm. long, with the branches obliquely disposed, and the open flowers almost pendulous.

The flowers are of a pale reddish colour turning whitish at mouth, with the genitals exserted 6—8 mm.; there is no basal swelling whatever, and only the slightest narrowing above the ovary. In this respect they somewhat resemble *A. grandidentata* Salm Dyck, but are considerably less clavate and have a much wider open mouth.

It seems that *A. suffulta* should be referred to the *Saponariae*, although it is not closely allied to any species in that section, and is distinguished by the channelled recurved leaves, and especially by the inflorescence being entirely supported by bushes.

FIG. 1.

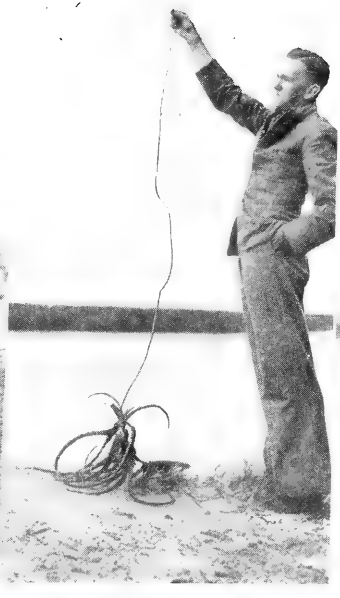


FIG. 2.

FIG. 3.

FIG. 4.

PLATE 26. *Aloe suffulta*, Reynolds.

FIG. 1. Illustrating a very typical plant, inflorescence 5 ft.

FIG. 2. Plant with 7 ft. inflorescence, which in natural habitat is supported by bushes.
Note.—For clearer detail, plants are illustrated away from their natural habitat ; fl. 13 June, 1937, near Vila Luiza (Marracuene) Mocambique.

FIG. 3. Upper portion of inflorescence, $\times \frac{1}{8}$ approx. Note pendulous open flowers.

FIG. 4. Flowers 1/1, from bud to post-pollination stage.

A species to be considered, and one about which very little appears to be known, is *A. Monteiroi* Bak., from Delagoa Bay. Berger (in *Das Pflanzenreich*, Liliac.-Asphod.-Aloin. 1908, p. 263) records this species from "Sofala Gaza-Land," and places it, together with *A. Cameronii* Hemsl., in the section *Monostachyae*, but Baker, in his original description (*Gard. Chron.* VI. 1889, p. 523) states " . . . . it comes nearest to *A. obscura* Miller (*A. picta* Thunb.)," which is a very different species from *A. Cameronii*. The figures of *A. picta* (now in synonymy under *A. obscura* Mill.) in *Salm. Monogr.* 1836—63, sect. 23, fig. 2, and in *Bot. Mag.* 1910, t. 1323, illustrate a plant near *A. saponaria* (Ait.) Haw. in leaf and flowers, but differing with longer conical racemes. It therefore seems that Berger was mistaken in allying *A. Monteiroi* to *A. Cameronii*, and that we should rely only on Baker's account.

It has been suggested that the Vila Luiza (Marracuene) species should be referred to *A. Monteiroi*, but from the description the latter is quite a different plant. Baker describes *A. Monteiroi inter alia* with "Peduncle *simple* above 1½ ft. long, raceme moderately dense . . . . perianth cylindrical an inch long, dull red tinged with green, tube constricted above the ovary, segments oblong ⅓ inch long, stamens and style considerably exserted. . . ."

In *A. suffulta* the peduncle is 5—9-branched, the inflorescence 5—7 ft. high, racemes laxly flowered, perianth 34 mm. long, not tinged with green, tube very slightly narrowed near the middle, segments free for 7 mm. only, and genitals exserted 6—8 mm.

Baker's species was described from a plant when it flowered for the first time at Kew, and as so often happens, the type described might not be typical of the species as found in its natural habitat. After allowing for this possibility, there are still too many points of difference for the Vila Luiza plants to belong to *A. Monteiroi* and they are therefore accorded distinct specific rank.

Photographs taken of *A. suffulta* in its natural surroundings in bush do not show the inflorescence clearly, therefore, for purposes of illustration, two plants are figured away from their natural habitat, which gives a better idea of the very slender peduncles, and the height and branching of the inflorescences.

Description.—Plant succulent, solitary under bushes, not suckering nor forming groups. *Stem* 10—20 cm. long, 15—20 mm. diam., foliate from ground level, with internodes 5—10mm. distant. *Leaves* about 16, sheathing at base, the sheathing portion striatulate, not auriculate, 4 cm. broad at base, gradually attenuate, mostly 40—50 cm. long. spreading and gracefully recurved ; upper surface usually deeply canaliculate, green

with dull white spots throughout, the spots about 5 mm. long, 2 mm. broad, sometimes irregularly scattered, usually more or less arranged in a series of interrupted undulating transverse bands; lower surface convex, duller green, spotted throughout, the spots usually larger, more confluent, and in broader less undulating bands; margins armed with whitish teeth 1—2 mm. long, 5—10 mm. distant, smaller and more crowded near base, gradually slightly larger and more distant upwards, usually hooked forward. *Inflorescence* one only, a branched panicle, usually about 1·75 met. high, supported by bushes. *Peduncle* exceedingly slender, about 8 mm. diam., branched well above the middle with up to 9 short branches, the peduncle and branches below racemes not sterile bracteate, lowest branch subtended at base by a thin, scarious, whitish, many-nerved bract up to 20 mm. long, 13 mm. broad at base. *Racemes* cylindric, slightly acuminate, the terminal about 15 cm. long, 5 cm. diam., laxly about 15—20-flowered, the buds rather horizontally disposed, not congested at apex, lateral racemes about 8 cm. long, with fewer flowers; the buds greyish-green striped in upper quarter, the flowers nearest Light Jasper Red (R.C.S. XIII) turning whitish at mouth. *Bracts* amplexicaul, thin, sub-scarious, whitish, about 7-nerved, as long as their pedicels. *Pedicels* lowest of terminal racemes 9 mm. long, slightly shorter in lateral racemes. *Perianth* 30—35 mm. long, very slightly stipitate at base, cylindric-trigonous, slightly curved, 6 mm. diam. near base, very slightly narrowing above the ovary (5·5 mm. diam.), thence enlarging towards the throat and forming a very wide open mouth. *Outer segments* free for 7 mm. from apex, the free portion with 5 congested dull brownish nerves confluent at apex, with a 1·5 mm. broad white border, and sub-acute spreading to recurved apices. *Inner segments* broader than the outer, with broader white border, and more obtuse spreading apices, dorsally adnate to the outer for their greater length. *Filaments* very pale rose-coloured, flattened, the 3 inner narrower and lengthening in advance of the 3 outer. *Anthers* exserted 6 mm. *Stigma* at length exserted 8 mm. *Ovary* 6 mm. long, 2·5 mm. diam., green, paler green at the 3 broadest angles giving a rather broad-striped effect.

UTRICULARIA: ITS DEVELOPMENT FROM THE SEED.

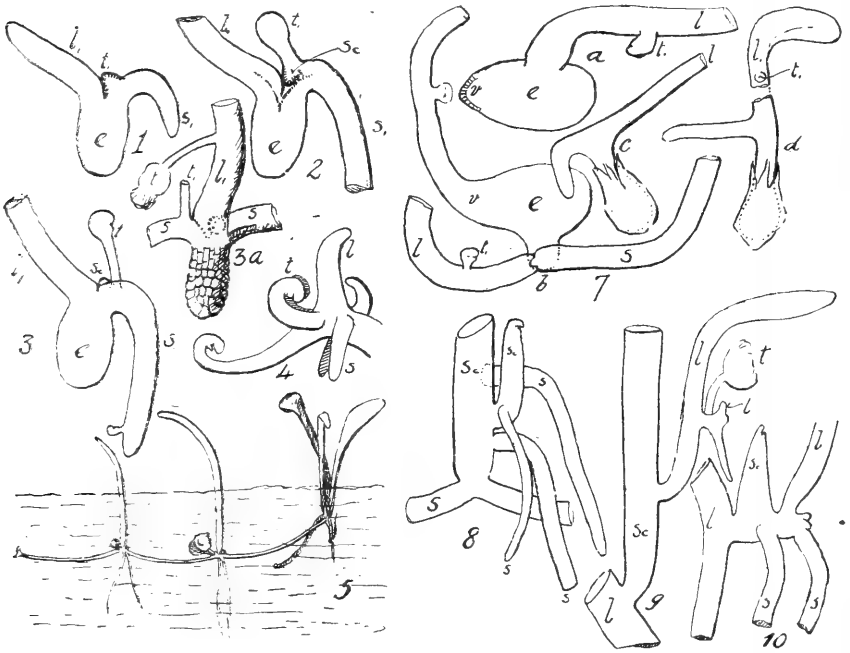
(With Plate 27.)

By Francis E. Lloyd.

Utricularia, together with Polypompholyx and Biovularia, genera of doubtful standing, consists of plants which are in many respects unique in their morphology. The many attempts to assimilate them in this respect with plants in general—that is, to find root, stem and leaf—were disposed of by Goebel, the foremost student of his time of the group. Without setting forth a summary of the controversy, we may say briefly (1) that there is no root ; (2) there is a stem which is the scape of an inflorescence, that rises secondarily from the body of the plant ; (3) this plant body, which differentiates itself into " leaf," " stem," "stolons " and " bladders," complicated as this becomes in some cases, is in its entirety of leaf nature. It is only when this point of view is adopted—with indeed what scepticism seems indicated—that anything like a rational description of the plant body becomes possible. The conventional definition of " leaf," the product of the older formal morphology, does not hold ; we have to describe what a leaf does physiologically rather than what it is. It is of unlimited growth and produces " leaves," " stems," organs which appear to be neither leaf nor stem, but which for a better term we call " stolons," special " shoots " (*e.g.*, the air shoots described by Goebel, in many floating species), " tubers " which completely violate the accepted definition of these organs, etc. The terms are put into quote-marks, since while used (in the lack of an entirely new terminology) they must be used in a physiological and in no strict morphological sense. A realization of the fundamental facts can be come by best by following the ontogeny of the plant beginning with the mature seed, though the inquiry might well begin with the early embryo, for something happens during its course of development which robs it of a root, so that the embryo as we find it in the seed lacks this organ entirely. (For information about the embryology one should read Merz, Merl and Lang.)

The species of Utricularia fall into two main groups of physiological import, (1) those which are more or less freely floating but submersed either totally (*U. flexuosa*), or with the upper surface of the leaves exposed

(*U. intermedia*), and (2) those which are always anchored in a substrate, loose or compact, but supplied with an abundance of water of greater or less permanence. In these latter the leaves may be large and of complex structure (*e.g.*, *U. reniformis*) reaching up into the air ; or may be small and scarcely rising above the surface of the substrate, and with simple structure. According to the duration of water supply of the habitat, these species may be evanescent, or of more or less protracted



Figs. 1-3. Successive stages in the germination of the embryo of *U. capensis : e*, embryo ; *l*, leaf ; *s*, stolon ; *t*, trap. 3a. An abnormal case (*U. capensis*) in which three organs (a leaf and two stolons) arose simultaneously from the growing point of the embryo. 4. The organs at the node of a running stolon in *U. monanthos : t*, trap ; *l*, leaf ; *s*, stolon. 5. *U. monanthos*, showing the habit of a young plant. Habitat : mud with water above. 7. Various behaviours during germination in *U. bifida : a*, Leaf produced on the flank of the seed instead of at vegetation apex (*v*) ; *b*, leaf only at vegetation apex and protuberance bearing leaf and stolon produced laterally ; *c*, vegetation apex grows into a mass bearing stolon and leaf without evident distinction at the base ; *d*, the primary leaf produces the primary stolon. 8. *U. capensis :* A scape has arisen from a stolon and from it a secondary scape and stolons have arisen : *sc*, scape ; *s*, stolons. 9. *U. capensis :* A scape has arisen from a leaf, and from the scape a leaf with a bud bearing leaf, trap and stolon : *l*, leaf ; *sc*, scape ; *t*, trap. 10. Similar to fig. 9, but the scape arises from a complex bud.

growth and generally of small size. Strict annuals or facultative or true perennials occur among these.[1] Of those species presenting a brief life cycle, the most striking known to me is Polypompholyx (Utricularia) of which two species *multifida* and *tenella* are recognised. The plants grow during the rainy season (winter rains) in temporary sandy swamps which on the on-coming of drought become quite dry. Seedlings were found near Perth in July, 1936 (under the guidance of Mrs. Eileen R. L. Johnson) with three to five leaves and as many or more traps, with the seed coat still attached to the embryo. From this material I am able to draw an account which I venture to believe is fairly correct. It will serve as a point of departure, as the simplest type from the developmental point of view of all.

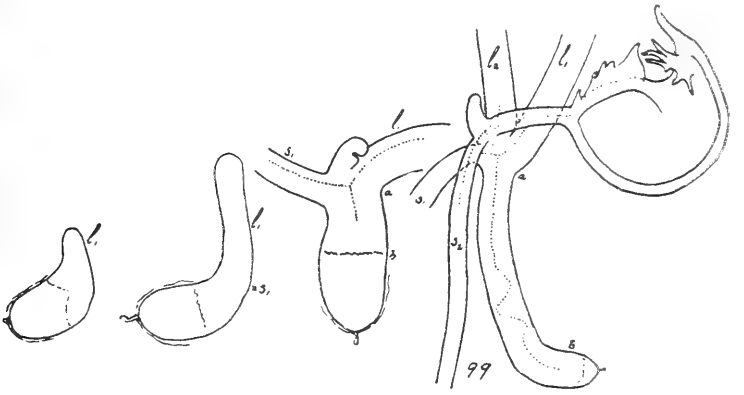


Fig. 6. Germination in *U. monanthos*.

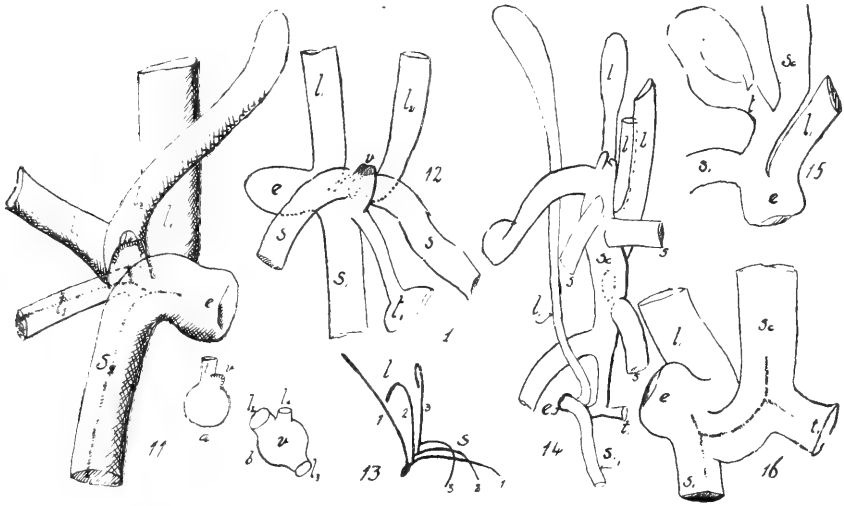
Abrupt Development.

The embryo is a rounded mass (ca. 0·2 mm. in diam.) somewhat concave on the root pole. The shoot pole is undifferentiated, it being clothed with simple columnar epidermal cells, with no prominences to indicate future organs. At an early stage of germination(2) two prominences appear (as in fig. 1), one of which elongates to form the first leaf; the other elongates similarly, but with downward growth, to form a colourless stolon. I call these "cotyledonoids" (figs. 11, 12). At the apex of the embryo between these two organs *there is no vestige of apical growth* and none is seen hereafter. The next definite step is the growth

(1) The taxonomic group "Natantes," often recognised, has no morphological value, though it may be useful in an artificial key.

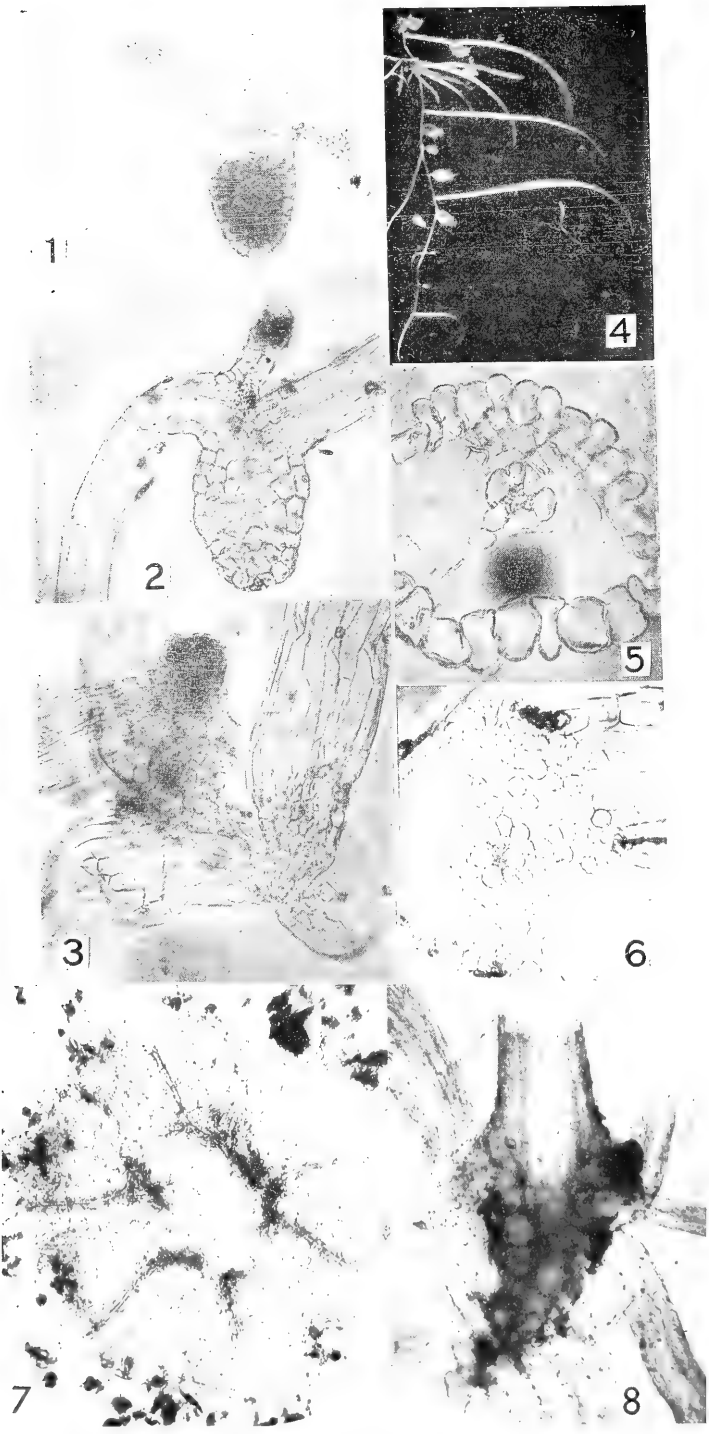
(2) Seed sent me by Mrs. Johnson supplied earlier stages of germination.

of the first trap, which arises near the base of the stolon and a little on one side (figs. 11, 12). From a point at or near the juncture of the stalk of the trap and the stolon from which it sprung arises a second swelling from which develops an axis growing vertically upward (figs. 14-16). In the vast majority of cases this axis is not distinguishable from its lateral organs ; but in about 5 per cent. of the seedlings, it elongates as if etiolated (fig. 14). It can then be seen to bear stolons, leaves and traps



Figs. 11. Polypompholyx. Young protocorm produced at the base of the primary trap, on the base of the primary stolon : *t*, trap ; *s*, stolon ; *e*, embryo ; *l*, leaf ; l_3 must be regarded as transparent : *a*, diagram, section of primary stolon to show relative positions of first trap and protocorm ; *b*, positions of leaves 2-4 on the protocorm (approx.) ; *v*, growing point of protocorm. 12. *U. capensis* : The same relations as seen in fig. 11. 13. Diagram to show succession of leaves and stolons in a seedling of *U. bifida*. 14. Somewhat advanced seedling of Polypompholyx ; *sc*, protocorm which at length ends in a scape. 15. The basal portion of a similar seedling of Polypompholyx to show the protocorm united with the stalk of the primary trap, and both arising from the primary stolon. 16. Detail of the seed region of fig. 14.

in no obvious order. The axis becomes thicker towards the growing apex about which new stolons, etc., are formed until at length a terminal scape is produced. The radial axis and the stolons which have arisen produce traps which are of two kinds : large ones on short stolons near the surface of the substrate, and small ones on longer stolons usually penetrating deeply. The size of the large traps relatively to that of the plantlet is quite enormous. No runner stolons are produced.


1
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7
8

A question must now be asked, namely, what is the morphological nature of the axis. When it first arises it seems to be identical in structure with that of a stolon. Its origin is the same and cannot be distinguished from that of the stolon or a trap, and is often concrescent or fasciated with the stalk of the first trap (fig. 15). It has only a single strand of vascular tissue, with a single spiral vessel. As lateral organs (stolons, traps or leaves, in no recognizable order) appear, strands, branches of the central, are given off, one to each. As maturity of the plant is reached, the axis, at first composed of delicate parenchyma, becomes somewhat more compact, the whole becoming corm-like in aspect (Plate 27, figs. 7, 8). The central strand gradually spreads out by means of branches to form a sort of central cylinder, but the structure is loose and ill-defined. Only when the scape is formed at the apex does the vascular tissue render the whole stem-like. We may say therefore that an organ at first not distinguishable from a stolon gradually assumes the character of a true stem.

The above account is applicable also to *U. violacea*.

It is a puzzling question as to the nature of the embryo. There seems to be no portion of it which constitutes a stem meristem. The evidence indicates that there is none, and that any area of the whole embryo is capable of producing the initial organs, stolon and leaf. I have found embryos of *U. bifida* which behave in this way (fig. 7).

The above method of development may be described as "abrupt," since the plantlet proceeds at once, after the original organs are laid down, to form an axial organ, the corm we may call it, which terminates in a floral scape.

In some species (*U. Menziesii*, *U. volubilis* and others ?), this corm is perennial. Although definite evidence is lacking it seems highly likely that it arises as it does in Polypompholyx. In *U. Menziesii*, the corm is upright. The tapering basal portion dies off, and it grows at the upper pole, giving off numerous traps, stolons, leaves, scapes and tubers. The latter may be regarded as water storage organs. The plant grows in the same sort of habitat as Polypompholyx, in a loose sandy substrate.

PLATE.

Plate 27.—1. *U. capensis* : Young stage of germination. 2. Somewhat later stage of germination : *U. capensis*, cf. text figs. 1-3. 3. The protocorm has taken form ; it is seated on the primary stolon. *U. capensis*. 4. Runner-stolon, *U. capensis* : near the left end a new scape will arise. 5. Transverse section, leaf base, *U. capensis* : large intercellular space in which the vascular strand is suspended by a small amount of chlorenchyma. 6. Transverse section through the lower part of a protocorm of Polypompholyx. 7. Traverse section of a mature corm of Polypompholyx. 8. Mature corm of Polypompholyx, with base of scape : a second scape is forming on the right.

Diffuse Development.

When, however, instead of producing a scape, other organs, leaves, stolons, traps, only are formed, the scape being produced adventitiously from a stolon, such behaviour may be termed diffuse. In some species, however, a scape is developed at once, and further stolons extensive in function, leaves, etc., arise secondarily. It is very difficult to get material of suitable stages for examination of this point. However, that of *U. monanthos*, grown for me at the Edinburgh Botanic Garden, supplies the evidence for that species.

U. monanthos—The germinating embryo elongates at one pole, the whole elongation becoming a leaf from which then, near its base, a stolon emerges (fig. 6). From this, near the leaf base but not quite in the middle line, a trap grows, accompanied somewhat later by a stolon. The growing mass of tissue which gives rise to the trap enlarges to accomplish this, until a definite bud is formed which may take on the character of a corm ; and while it is doubtful if a scape arises from it, it would be no surprise if it occasionally did so.

It is clear that this bud arises secondarily from the first stolon, not directly from the embryo (agreement with Polypompholyx). From this, as a focus, arises a stolon which becomes a major axis, creeping horizontally through the substrate (fig. 5). Others arise later. On the stolon at nodes arise in definite order the usual complement of organs, a single leaf, median above in position, traps and stolons in pairs, a second median organ being probably a leaf (fig. 4). This is the general scheme, further study being required to trace definitely the fate of all buds. In this plant, as Goebel pointed out for *U. orbiculata*, the upper face of the leaf is addressed towards the original axis and not towards the apex of the stolon which bears it, as if the stolon itself were but the leaf stalk capable of proliferating. This is rather surprising. It means that the original orientation or polarity is not lost. The stolon is not a branch in the accepted morphological sense. Nor is its anatomy more helpful, for there is but a single delicate strand of vascular tissue with one, perhaps two, spiral vessels running along the upper side of the phloem.

U. capensis—The course of events is the same for *U. capensis*, only that in this species (*a*) there is always normally produced a scape directly from one of the cotyledonoids of the embryo, as described for Polypompholyx, and from the base of this new scapes may arise adventitiously as in fig. 8 ; and (*b*) from the protocorm, running stolons originate to give rise to secondarily produced scapes (fig. 8), and this may continue as long as wet habitat conditions persist. The production of stolons may often precede that of the scape. I found in August 1929 on Table Mountain a bed of moss with a few leaves of *capensis* showing. On carefully

pulling the substrate apart later I found seedlings in various stages, most of which however already showed a young scape, and all with several long running stolons with many traps (Plate 27, fig. 4). The running stolons bear leaves at intervals, but there is no definite plan of arrangement followed by the traps and stolon branches (as in *U. monanthos*). Stolon branches are usually lateral ; traps occur from any point, though chiefly lateral (Plate 27, figs. 1-4 ; text figs. 1-3, 9, 12).

But the course of development from cotyledonoid to scape is not always as direct as above described. Seedlings of *U. bifida* showed the following behaviour. The first stolon arises from the base of the first leaf. This relation is alternative with the condition that both arise simultaneously from the embryo (fig. 7). In the former case we probably have to do with the elongation of the embryo below the level of origin of the cotyledonoids ; but in any case the leaf appears first. From near the base of the first stolon arises a second leaf, which later emits a stolon near its base, this sequence to be repeated for some time. The scheme is set forth in the diagram herewith (fig. 13).

In Polypompholyx, *U. violacea*, *U. capensis*, the protocorm normally arises in the position of leaf 2 in this diagram ; but occasionally (in nature) the process may be delayed, the individual following the above scheme. Here also it should be noted that in the position of leaf 2, a trap only may arise at first, another organ (protocorm or other) arising from a vegetation point at its base.

Little light can be got concerning these sequences except by direct observation of the growing plants. The above descriptions are based on such observation. Heretofore no exact account of these relations has been published. Kamienski made a drawing of an early stage (only the two cotyledonoids and a trap showing) of *U. lateriflora* (Engler and Prantl). Goebel examined the seedlings of two species, *U. bifida* and *U. elachista*. The youngest stages only of the former were seen. His illustrations show clearly that he recognised that a new organ appears at the base but not on the middle line of the primary stolon,[1] it being regarded as a radially constructed organ, and called by him á " shoot vegetation point," but as he did not follow its development his interpretation is open to question. He makes the guess that it ends in forming the inflorescence ; but I have found that it develops into the second leaf

[1] I find that I misrepresented Goebel's view in my review paper (Lloyd 1935, bottom of page 74 and top of page 75), and the footnote was robbed of its meaning by the use or " former " for " latter." What Goebel seems to have meant is that the vegetation point appears first between the " cotyledons " and later on the base of the stolon presumably by elongation of this organ at the base. If I now represent Goebel correctly, I think he was mistaken.

(in *U. bifida*), while in Polypompholyx a trap, followed at its base by a radial structure which ends in a scape, is formed. I have found evidence to suspect that seedlings grown under unnatural conditions do not always behave quite usually, and Goebel's interpretation may well be true for naturally grown seedlings, though evidence is wanting on this point. Of *U. elachista* Goebel saw only a " seedling " which had as a matter of fact become a mature plant (as it bore a flower) and the steps of development were no more to be traced. He says indeed that the germ-shoot is radial, but he does not and could not have traced its origin in his material. Nor does he tell us about the vascular structure, this being such as to halt us when we incline to say radial.

Utricularia capensis.

Since in the Cape Province we are particularly interested in *U. capensis*, we shall extend our description of this species in some detail. The embryo, which is oval (ca. 0·2 × 0·3 mm.), normally produces during germination, raised on an extended upper zone (the upper half of the embryo lengthens) (Plate 27, fig. 1) two cotyledon-like structures ("cotyledonoids "), one of which growing upwards becomes a leaf, the other, growing initially downwards, a stolon (text-figs. 1-3). On the stolon near its base but not quite in the middle line appears the first trap (Plate 27, fig. 1, and text-fig. 1). From a growing point which occurs partly on the base of the trap stalk and partly on the stolon a radial structure, the protocorm, (Plate 27, fig. 2, and text-fig. 3) develops. Whether this growing point arises *de novo* or is a persistent portion of the original growing point which gave rise to the first trap, cannot at the moment be said ; and this question applies equally to other species above considered. It is important to note that the size of the trap stalk overshadows that of the growing point (Plate 27, fig. 2, and text-fig. 2), and this may have confused the issue. This disparity of size between the growing point and the lateral organs springing from it is a constant feature peculiar to these plants, and makes difficult a clear picture on dissection.

The procedure above presented is not always followed. Abnormal germinations occur which are not without interest, since they illustrate a high degree of plasticity possessed by Utricularia. Among seedlings grown in living Sphagnum in a vial I obtained one in which three initial organs were produced, a leaf and two stolons, set in a triangle much as in the case of *U. emarginata*, one of the Natantes (Goebel). From one stolon the first trap was produced, from the leaf later several others, and at its base there is a growing point which appears to be the corm (fig. 3a).

It may, however, be intended as a stolon, and there is no way of deciding. The germination of Utricularia offers a wide and interesting field for observation.

The protocorm must be regarded as radial (Plate 27, figs. 1-3, 6-8), As it develops it produces from all sides leaves and stolons which travel out, spreading in the substrate, and from them arise leaves, facing the origin, not the apex, of the bearing stolon (Plate 27, fig. 4). The bud elongates and at the same time thickens to form a corm which bears leaves and stolons and at length a scape, the primary. From its base, without a bract, and partly or wholly from the top of the corm, a second and even third scape may arise. Secondary scapes arise also from the upper surface of the running stolons and from leaves (figs. 8-10), and in this way the period of flowering is prolonged indefinitely. With the guidance of Mr. Middlemost it was found growing and profusely flowering on wet rocks in Bain's Kloof on March 8, 1936, long past the season in places subject to drought.

The body of the corm is composed of a very soft, spongy parenchyma of globose cells held together by short bridges, the whole having little mechanical strength (Plate 27, fig. 6). The epidermis is very frail and the surface is broken up by the numerous bloated stolons, traps and leaf-bases. The bloating is owing to the extensive intercellular spaces, so that stolons and leaves are little more than tubes traversed by a single vascular strand. In corm, leaf and stolon this vascular strand is asymmetric, for if xylem is present it occupies a position on one side of the phloem. In the corm there is at first only a single central vascular strand (Plate 27, fig. 6), its asymmetric character detracting from the perfect symmetry of a radial organ. As the corm develops it becomes larger, and the vascular strands tend to travel outward more and more in order to enter the lateral organs. As the upper regions of a mature corm are reached the strands have spread out so as to form an irregular circle of about six or seven groups of vessels (Plate 27, fig. 7), but without any striking order or symmetry. Only when the definitive scape is reached is there any great measure of radial symmetry attained. Here the phloem and xylem travel more or less independently, as Hovelacque long ago showed.

Stolons and leaves have the same structure aside from the secondary features of palisade tissue, etc. (Plate 27, fig. 5). A single vascular strand only is present and the xylem is always above the phloem and not, as one would expect, below. This is only one of the paradoxes presented by these peculiar plants.

Both leaves and stolons are beset with traps (Plate 27, fig. 4) which occur, in contrast with the condition in *U. monanthos*, quite irregularly,

scattered along the flanks and upper surface, and on the edges or backs of leaves.

The purpose of this paper, to furnish an account of the origin of the various organs in relation to the embryo, has been accomplished. The chief point to be emphasized is that the origin of a " radial " structure, which produces various organs, but at length a flowering scape, is secondary in that the point of origin is on and near the base of the primary stolon which holds the position of a cotyledon.

No consideration has been given to the so-called " Natantes," meaning here the *U. vulgaris* group, studied by Kamienski, Warming and Merl, for the reason that the facts are well known while the institution of a comparison of these with those forms which have been here examined would involve a lengthy discussion beyond the scope of our purpose.

Citations.

GOEBEL, K.: Morphologische und biologische Studien, V. Ann. Jard. Bot. Buitenz. 9: 41-119. 1891.

HOVELACQUE, M.: Recherches sur l'appareil vegetatif des . . . Utriculariacees. Paris, 1888.

KAMIENSKI, FR.: " Utricularia." Krakow Akad. 3: 211-240. 1876.

LANG, F. X.: Untersuchungen ueber Morphologie, Anatomie und Samenentwickelung von Polypompholyx und Byblis. Flora, 88: 149-206. 1901.

LLOYD, F. E.: Utricularia. Biol. Rev. 10: 72-110. 1935.

MERL, E. M.: Beiträge zur Kenntniss der Utricularien und Genliseen. Flora, 108: 127-200. 1915.

MERZ, M.: Untersuchungen ueber die Samenentwickelung der Utricularien. Flora, 84: 69-78. 1897.

WARMING, E.: Bidrag til Kundskaben om Lentibulariaceae. Vidensk. Medd. naturh. Foren. Kbh. Nos. 3-7, 33-58. 1874.

NOTES ON JUNCUS.

By R. S. Adamson.

Some additions to and corrections of the " Revision of the South African Species of Juncus " published in 1935 (Journ. Linn. Soc. Bot. L. 1) are now put on record. These are concerned mainly with the annual species of the series " graminifolii " where one new species is described, one other is added to the list, and the available descriptions of others amplified. Some extensions of range are recorded.

The species are referred to by the numbers used in the " Revision." For several notes on localities in the Transvaal I am indebted to Dr. J. Burtt-Davy.

6. *J. acutus* L. Malmesbury Div., near Darling. Adamson 487.

7. *J. Kraussii* Hochst. This species which was not previously recorded to the north of Table Bay is not uncommon along the coast at least as far as Saldanha Bay. Adamson 488.

10. *J. oxycarpus* E. Mey. Burtt-Davy 17358 is from Amersfoort, Wakkerstroom Div. ; Burtt-Davy 17694 is from Heidelburg, Vereeniging Div.

13. *J. exsertus* Buchen. Nelson 320 is from Ysterspruit, Potchefstroom, not from E. Transvaal.

14. *J. rostratus* Buchen. By error the Transvaal localities were placed under Swaziland. The plant is represented from that territory by Rogers 13.

15. *J. lomatophyllus* Spreng. var. *congestus* Adamson. Wilms 1565 is from Lydenburg.

16. *J. viridifolius* Adamson. Krakadouw Peak, 5500 ft., Cederberg Range (Adamson 462). This is a considerable extension of the known range.

20. *J. indescriptus* Steud. Rehmann 5742 is from Houtbosch, Pietersburg. Dr. Burtt-Davy informs me that the Stoltz collections were made in S.W. Tanganyika, not in Nyassaland.

28a. **J. obliquus** Adamson, n. sp. Annua, parva, 1—3 cm. alta. *Caules* tenues foliis basilaribus filiformibus duplo longiores, basin et vaginae rubescentes. *Capitulum* unicum pseudolaterale vel subterminale. *Flores* 1—4, parvae, c. 2 mm., castaneae. *Bracteae* omnes hypsophyllinae, membranaceae, castaneae, floribus breviores. *Tepala*

externa distincte breviora, acuta, interna involuta plus minusve obtusa. *Stamina* tria, tepalis internis opposita et triplo breviora. *Antherae* subrotundae filamentis breviores. *Stylus* brevis. *Capsula* perianthio brevior, rotundato-trigona, ferruginea, mucronata. *Semina* parva obovata.

Banks of temporary streams among mosses. Ebenezer, Cold Bokkeveld Mountains, Ceres Div., Cape Province. Adamson 1139 (type), Levyns 5791. A small annual with an external resemblance to a *Scirpus*. Stems are usually solitary.

A very distinct species owing to the pseudolateral inflorescence, brown scarious bracts, short outer perianth, three stamens with short rounded anthers, and short style. The plant is most nearly related to *J. capitatus* Weig. but very different.

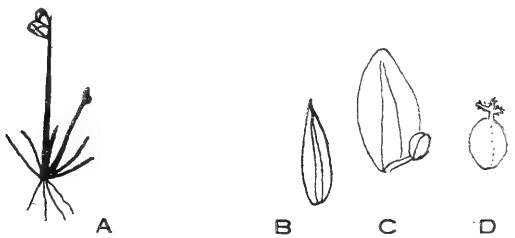

FIG. 1. *J. obliquus*, Adamson. *A*. Complete plant (nat. size). *B*. External perianth segment. ×10. *C*. Internal perianth segment with stamen. ×10. *D*. Capsule at time of flowering. ×10.

29. *J. cephalotes* Thunbg. This species appears to have a wider range and to penetrate further inland than was known. New localities are : Ceres Div., Ceres, Levyns 4707 ; Cold Bokkeveld Mts., Adamson 1119 ; Tulbagh Div., Roodesand Kloof, Adamson 1013 ; Bredasdorp Div., The Poort, Levyns 4510 ; Vogel Vlei, Levyns 4547 ; Robertson Div., Eendragt, Levyns 313.

32. *J. pictus* Steud. This plant which was hitherto known only from Drège's specimens appears to be rather abundant in suitable localities, by streamlets between 4,000 and 5,000 ft., in the Kamiesberg. Adamson 1467, 1469, 1488. An examination of a series of specimens has made possible a completion and amplification of the description.

Stems 10—15 cm. much exceeding the narrow, usually glaucous leaves. Inflorescence of 1—3 heads each 5—8-flowered. Flowers pale, c. 5 mm. Perianth dark at tip or with a dark central spot, external much shorter acuminate almost aristate. Stamens equalling outer

perianth with anthers much longer than filaments. Style long, stigmas pale exserted. Capsule as long as outer perianth, red brown, trigonous with rounded angles, blunt, shortly but distinctly mucronate. Seeds yellow oval, shortly apiculate, with pale margin. Flowers Dec.—Jan.

34. *J. polytrichus* E. Mey. and Buchen. This had been refound at Leliefontein, Adamson 1492. It is apparently rare. A much smaller plant than *J. pictus* ; flowers 3—3·5 mm. red-brown. External perianth slightly shorter acute. Stamens two-thirds perianth with short filaments. Capsule half to two-thirds perianth, rounded, bluntly three-angled, apiculate. Seeds pale brown broadly oval, not margined,

35. *J. filifolius* Adamson. Near Bottelary and Sarepta. Acock.

36. *J. scabriusculus* Kunth. A re-examination of the material of this species has been undertaken owing to the discovery of specimens growing by a stream on the Nardouw Mountains near Clanwilliam (Adamson 1412) which show several points of difference from the descriptions though with a general resemblance. The Nardouw plants agree very closely with Buchenau's figure and description of *J. subglandulosus* Steud., which was founded on a part of Drège 8795. This number comprises two gatherings, the larger plant was taken by Steudel as the type of *J. subglandulosus*. The specimen, a single plant, is immature and was regarded on examination and comparison as a growth or habitat form of the commoner *J. scabriusculus* (Rev. 36). The new gathering (Adamson 1412) which was abundant and quite uniform exhibits several decided differences from *J. scabriusculus*, notably in an unequal perianth and short rostrate capsule. Kunth (Enum. Pl. III 304) in his original description says of *J. scabriusculus* "*J. bufonio maxime affinis.*" This might be applicable to the common form but is certainly not the case with these Nardouw plants. The differences are such that they should be classed as a separate species. As they agree so closely with Buchenau's figures (much more closely than does the specimen from which they were made) the name *J. subglandulosus* as emended by Buchenau may be revived for them. Neither Steudel nor Buchenau had seen a mature plant in which the most distinctive characters are shown. The amended description is :—

36a. *J. subglandulosus* Steud. emend Buchenau (amplified). Steudel Syn. Pl. Glum. II, 303, 1841 ; Buchenau Monog. Junc. v. Cap. 459 Taf. VI 1875 ; *J. scabriusculus* Kunth var. *subglandulosus* Buchen. Engler. Bot Jahrb. XII 458, 1890 ; Baker Fl. Cap. VII 22, 1897.

Annual, 20—25 cm., subglaucous. Leaves and sheaths reddish, much shorter than stem. Inflorescence umbellate. Heads 1—6 (occasionally 8), central sessile, others stalked. Stalks 1—2 cm. occasionally with 2 heads. Heads 6—10-flowered. Flowers pale, 4—5 mm. Lowest

bract shortly leaflike, others membranous, cuspidate, shorter than the flowers. Perianth unequal, external shorter, distinctly keeled. Stamens 6, two-thirds perianth, anthers white, filaments very short. Style long. Capsule yellow-brown, rounded trigonous with depressed sides, distinctly apiculate or rostrate, about equal to external perianth. Seeds rounded.

Streamsides on clay soils. Nardouw Mt., Clanwilliam, Adamson 1412; Piquetberg, Drège 8795 p. pt.

The main differences between the two species may be tabulated :—

scabriusculus	*subglandulosus*
Perianth equal, thin.	External perianth longer, keeled.
Stamens half perianth.	Stamens two-thirds perianth.
Anthers yellow, filaments short.	Anthers white, filaments very short.
Capsule cylindric-trigonous, blunt or retuse, very shortly mucronate.	Capsule rounded, distinctly rostrate.
Stems 5—15 cm.	Stems 20—25 cm.

The range of *J. scabriusculus* has been extended by its discovery near Bredasdorp. (The Poort, Levyns 4451.)

38. *J. rupestris* Kunth. Cold Bokkeveld Mts., Ceres. Adamson 447.

39. *J. umbellatus* Adamson. Sarepta, Stellenbosch. Acock.

The addition of two species to the list and the completion of the description of others renders some modification of the key to the species in the series "*graminifolii annui*" necessary and the following is given as an alternative :—

A. Heads pseudolateral or oblique, 1 or few. Stamens 3.
  B. External perianth longer, aristate. Flowers pale 28. *J. capitatus.*
  BB. External perianth shorter, acute. Flowers dark.. 28*a*. *J. obliquus.*
AA. Heads terminal, one or many. Stamens 6.
  B′ Internal perianth distinctly longer
    C. Heads with 6 or more flowers.
      D. Anthers equalling filament. Flowers dark .. .. .. 30. *J. inaequalis.*
      DD. Anthers longer than filament. Flowers pale.
        E. External perianth keeled, pale. Seed round .. .. .. 36*a*. *J. subglandulosus.*
        EE. External perianth not keeled, dark at tip. Seed ovate, margined .. .. .. 32. *J. pictus.*
    CC. Heads with 1—4 (occasionally 5) flowers.
      D′ Very small. Heads solitary. Flowers pale. Capsule equalling perianth, mucronate .. 33. *J. parvulus.*
      D′D′ Taller. Heads 1—3. Flowers brown. Capsule shorter than perianth, apiculate .. 34. *J. polytrichus*

B′B′ Internal perianth equalling or shorter than the external.
C′ Internal perianth acuminate .. .. 31. *J. Sprengelii.*
C′C′ Internal perianth involute, more or less obtuse.
D′ Style at least as long as ovary.
E′ Heads with many flowers, 5 or more.
F Flowers dark. Leaves flat broad 29. *J. cephalotes.*
FF Flowers pale. Leaves narrow or filiform.
G. Flowers 4—7 mm. Plant glaucous. Capsule blunt or shortly mucronate .. 36. *J. scabriusculus.*
GG. Flowers 3—4 mm. Plant reddish. Capsule distinctly mucronate .. 35. *J. filifolius.*
E′E′ Heads few flowered, 1—4, rarely 5.
F′ Leaves flat. Inflorescence umbellate .. .. .. 39. *J. umbellatus.*
F′F′ Leaves filiform. Inflorescence cymose .. .. .. 38*b*. *J. rupestris* var. *Schlechteri.*
D″D″ Style very short or none.
E″ Heads 8—15-flowered. Flowers pale 37. *J. diaphanus.*
E″E″ Heads 1—3-flowered. Flowers brown .. .. .. 38. *J. rupestris.*

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